SECTION 815 — CAST ALUMINUM BRIDGE RAILING POSTS

815.01 CHEMICAL COMPOSITION. Conform to ASTM B 108, Alloy A 356.0. Contrary to ASTM B 108, heat treat to a T6 temper instead of T61 to produce the following tensile properties:

TENSILE PROPERTIES [1]		
Properties	Minimum	Typical
Tensile Strength, psi [1]	25,000	30,000
Elongation in 4x Diameter, % [2],[3]	6	8

[1] *For the purposes of design in the tension test, ensure that the specimens conform to the minimum yield strength of 18,000 psi (acceptance testing for this property is not required).*

[2] *Minimum tensile properties based on separately cast test bars are 32,000 psi tensile strength and 10 percent elongation.*

[3] *Gage length 4 times the diameter of the specimen.*

815.02 TEST SPECIMENS. Machine the tension test specimens from integrally cast test coupons extending from one side of the base of the posts sufficiently large enough to obtain an 0.350-inch diameter test specimen as defined in ASTM E 8.

815.03 TESTING. Sample a minimum of one percent of the posts in any lot, but not less than one, for tensile testing. For the purpose of sampling, a lot shall consist of not more than 1,000 pounds of clean castings when produced from a batch type furnace charged with one heat of ingot of known analysis or not more than 2,000 pounds of clean castings when produced from one continuous furnace in not more than 8 consecutive hours.

Determine tensile properties according to ASTM E 8. When the results of any tensile test do not conform to the requirements prescribed, perform 2 additional tests on the same group of castings. The average of the 3 tests must conform to the requirements.

815.04 HEAT TREATMENT. Heat treat the castings to produce material with the utmost uniformity conforming to the properties specified in this section. Perform heat treatment on the whole casting, never on a portion only.

815.05 WORKMANSHIP AND FINISH. Ensure that castings are uniform in quality and condition, free from cracks, blowholes, porous places, hard spots, shrinkage defects, or other defects that may detrimentally affect the suitability of the castings for their intended use. Ensure that the castings are smooth and well cleaned before inspecting.

Produce castings under radiographic control. Radiographically examine castings to establish proper foundry technique for each mold that will produce castings commercially free from harmful internal defects, and examine production castings to ensure maintenance of satisfactory quality.

Provide a normal mill finish.

815.06 INSPECTION. The Department may inspect the manufacturer's work either where the castings are made or at the point at which they are received.

The Department will either visually inspect the castings or compare the castings by a method adopted as standard to determine compliance with the requirements of Subsection 815.05.

When the Department elects to have inspection made at the manufacturer's works, the manufacturer shall afford the inspector representing the Department all reasonable facilities to verify that the material is being furnished according to this section. The

Department will conduct all tests and inspection in a manner not interfering unnecessarily with the operation of the works.

815.07 INSPECTION REPORTS. When requested by the Department, furnish certified inspection reports certifying compliance with the requirements of this section.

SECTION 816 — WOVEN-WIRE FENCING MATERIALS

816.01 DESCRIPTION. This section covers the materials for use in construction of woven-wire fences.

816.02 GENERAL. Galvanize all ferrous materials used in a complete installation of fence, except aluminum coated fabric, aluminum coated posts and braces, or aluminum coated barbed wire. Galvanize all iron and steel hardware according to AASHTO M 232. Galvanize other components as designated. Where it is not practical to secure a specimen of measurable area or uniform thickness for determining the weight of zinc coating, ensure that all such galvanizing withstands 4 dips of the Preece Test as set out in ASTM D 2521. Ensure that post caps and socket type brace connections are galvanized malleable iron, or other approved type, and designed to exclude moisture from inside posts or rails.

816.03 WOVEN WIRE FABRIC. Ensure that the woven wire fabric is either zinc-coated steel or aluminum-coated steel. Provide the size and style of fabric specified in the Contract.

Use zinc-coated steel fabric that conforms to ASTM A 116 and that has a Class 3 coating.

Use aluminum-coated steel fabric that conforms to ASTM A 584.

816.04 BARBED WIRE. Use either zinc-coated steel, aluminum-coated steel, or aluminum alloy. Use barbs of 4-point pattern spaced at intervals of 5 inches. The wire for barbs may be either round or half-round.

816.04.01 Zinc-Coated Steel. Conform to ASTM A 121. Use size 0.099-inch diameter or heavier with Class 3 coating. The Department will allow high tensile strength barbed wire provided it conforms to ASTM A 121, and the following exceptions: (1) nominal diameter of 0.067 inch for the coated line wires and 0.057 inch for the coated barbs; (2) minimum weight of zinc coating of 0.75 ounces per square foot for line wires and 0.70 ounces per square foot for barbs; and (3) minimum tensile strength of 475 pounds for each individual strand of the line wire.

816.04.02 Aluminum-Coated Steel. Use either Type I or Type II conforming to ASTM A 585. Use size 0.01 inch diameter or heavier.

816.04.03 Aluminum Alloy. Use 2 strands of 0.110 inch nominal diameter or heavier wire strands having minimum tensile strength of 42,000 psi, minimum yield strength of 35,000 psi and minimum elongation of 10 percent.

816.05 BRACE WIRE. Conform to ASTM A 777-91 except provide a minimum weight of coating of 0.6 ounce per square foot. Use size 0.148-inch nominal diameter or larger.

816.06 FABRIC TIES. Use either a minimum 0.109-inch nominal diameter galvanized steel conforming to ASTM F 626, except ensure that the minimum weight of coating is 0.6 ounces per square foot, or 0.148-inch nominal diameter aluminum alloy.

816.07 FENCE POSTS AND BRACES.

816.07.01 Steel Posts and Braces. Conform to ASTM F 1043, ASTM F 1083, and the Standard Drawings.

When the Contract specifies a thermoplastic acrylic coating, apply a chromate conversion coating at the manufacturer's recommended rate. Ensure that the coating is designed for pretreatment of galvanized coatings. After pretreating, electrostatically apply the thermoplastic acrylic coating with a minimum dry film thickness of 0.3 mils.

816.07.02 Wood Posts and Braces. Treat wood fence posts and braces with preservative and ensure that they are made of timber cut from live, sound, standing trees. See Subsection 818.01 for inspection, testing and acceptance of wood products. Ensure that round or half-round posts and braces are preservative treated according to and are of the species covered by AWPA C 5. Ensure that sawed posts and braces are preservative treated according to and are of the species covered by AWPA C 2 for "Soil or Fresh Water Exposure".

Use posts that are round, half-round, or square-sawed.

Ensure that wood for fence posts is sound and free from decay, excessive knots, seasoning checks, and end splits that will affect serviceability. The Department will allow sound knots, provided the width of the knot does not exceed one-third the diameter of a round post at the point where it occurs, or one-third the width of any face of a sawed post, or a maximum of 2 1/2 inches. The Department will reject wood with season checks that penetrate more than one-third of the diameter of the piece or which have a width of more than 1/4 inch.

Use round posts and half-round posts that are free of multiple crooks. The Department will allow crooks in one plane only, provided that a straight line between the centers of the butt and tip does not deviate more than 2 inches from the center of the post at any point. Ensure that crooks in square-sawed posts do not exceed one inch in 5 feet.

Cleanly peel round posts and remove all bark. Strips of inner bark that are less than 1/2 inch wide and 3 inches long may remain on the peeled post. Trim all protruding knots flush with the sides and remove all spurs and splinters. In machine peeling operations, follow the natural taper of round posts. Manufacture half-round posts by sawing in half the round posts complying with the above manufacturing methods.

Square cut the ends of all posts unless the Engineer allows driving. When driving is specified or allowed, point the butt end before receiving preservative treatment. Do not allow the length of the point to exceed 1.5 times the diameter or width of face, as applicable.

A) Line Posts. Use line posts with a length of 7 feet and a minus one-inch tolerance. Use line posts that are either round, half-round, or square-sawed; however, furnish the same type section for all line posts throughout the project.

Ensure that round posts have a minimum diameter of 4 inches. Ensure that half-round posts have a minimum face of 6 inches and a minimum radius of 2 3/4 inches. Cut square-sawed posts to 4-inch by 4-inch, ± 1/8 inch.

B) End, Corner, Gate, Brace, and Pull Posts. Do not use lengths less than 8 feet. Use either round or square-sawed posts; however, furnish the same type section for all of these types throughout the project. Ensure that round posts have a minimum diameter of 8 inches. Cut square-sawed posts to 8-inch by 8-inch, ± 1/8 inch.

C) Braces. Conform to all requirements for line posts, except use braces that are either round or square-sawed and furnish them in the lengths specified in the Plans.

816.07.03 Untreated Wood Posts. Furnish untreated wood posts of Osage-Orange, Black Locust, Red Cedar, White Oak, or of other approved species, and ensure that posts conform to all applicable requirements of Subsection 816.07.02. Use untreated wood posts only when specified in the Contract.

816.08 GATES. Fabricate gate frames to the size and dimensions specified in the Contract. Ensure that pipe used in frames conforms to Subsection 816.07.01. Weld or otherwise construct all joints to form a rigid and water-tight frame.

Furnish all gates complete with approved hinges, latches, and auxiliary braces as required.

Fit gate frames with a fabric that conforms to the same requirements as the corresponding fence.

The Department may approve the use of gates fabricated of other materials.

SECTION 817 — CHAIN LINK FENCING MATERIALS

817.01 DESCRIPTION. This section covers materials for use in the construction of fences of chain link fabric. The Department will allow 3 optional types of fabric; zinc-coated steel, aluminum-coated steel, or aluminum alloy (Type I, II, or III fabric, respectively). Use vinyl coated fabric (Type IV) only when specified in the Contract.

817.02 REQUIREMENTS. Conform to AASHTO M 181 for all materials except steel posts and barbed wire.

817.02.01 Fabric. Use 0.148-inch nominal diameter wire woven in 2-inch mesh. Coat Type I fabric to conform to Class D. Furnish fabric for fences 4 feet and 6 feet high that has the top selvages knuckled and bottom selvage knuckled or twisted and barbed. Furnish fabric for fences 8 feet high or higher with both top and bottom selvages twisted and barbed.

817.02.02 Barbed Wire. Conform to Subsection 816.04.

817.02.03 Post Caps and Socket Type Brace Connections. Use galvanized malleable iron, or other approved type, designed to exclude moisture from inside posts and rails.

817.02.04 Posts, Rails, Gate Frames and Expansion Sleeves. With zinc-coated steel fabric or with aluminum-coated steel fabric, use either zinc-coated steel or zinc-acrylic coated steel. With aluminum alloy fabric, use aluminum alloy. Furnish steel posts that comply with Subsection 816.07.01.

817.02.05 Fabric Ties. Use either a minimum 0.148-inch nominal diameter aluminum alloy or 0.120-inch nominal diameter galvanized steel.

817.02.06 Hog Rings and Tension Wire. With zinc-coated steel fabric or with aluminum-coated steel fabric use zinc-coated steel wire or aluminum-coated steel wire. Ensure that steel ties and wire conform to ASTM F 626, except that the minimum weight of coating is 0.6 ounces per square foot. With aluminum alloy fabric, use aluminum alloy wire.

817.02.07 Miscellaneous Fittings and Hardware. With zinc-coated steel fabric or with aluminum-coated steel fabric use zinc-coated steel. With aluminum alloy fabric, use aluminum alloy.

SECTION 818 — WOOD PRODUCTS

818.01 INSPECTION, TESTING, AND ACCEPTANCE. The Engineer will visually inspect and approve all treated wood products before use on the project. The Division of Materials will grade inspect, sample, and test all treated wood products before their use on the project if the plant producing the wood materials is located within the Commonwealth or a 100-mile driving distance of its borders. When obtaining treated wood materials from a plant outside this 100-mile distance, have an independent treated-wood testing company approved by the Division of Materials grade inspect, sample, and test the wood treated material at no expense to the Department. Obtain a report prepared by the independent testing firm that grade inspected, sampled and tested the treated wood material, and submit it to the Division of Materials at least 15 days before using the wood materials on the project.

Use only treated wood that has been cut to size before treating. Treat field sawn surfaces according to AWPA M4.

818.02 BOARDS. Boards are defined as being less than 2-inch in nominal thickness and one inch or more in width. Only use boards that are one of the available grades established by either the Southern Pine Inspection Bureau (SPIB) or the West Coast Lumber Inspection Bureau (WCLIB). The Contract will designate the grade and applicable inspection bureau.

818.03 DIMENSION LUMBER. Dimension lumber is limited to surfaced softwood lumber of nominal thickness from 2-inch through 4-inch. Only use dimension lumber for framing members such as joists, planks, rafters, studs, and small timbers.

Use only dimension lumber boards that are one of the available grades established by either the SPIB or the WCLIB. The Contract will designate the grade and applicable inspection bureau.

818.04 TIMBERS, 5-INCH BY 5-INCH AND LARGER. Use only timbers that are of one of the available grades established by either the SPIB or the WCLIB. The Contract shall designate the dimensions, grade, species, and applicable inspection bureau.

818.05 STRUCTURAL LUMBER. Conform to the AASHTO Standard Specifications for Highway Bridges.

818.06 BRIDGE PLANKING AND ROUGH LOCAL HARDWOODS.

818.06.01 Species. Use only bridge planking that is White Oak, Red Oak, or Southern Yellow Pine.

The term “White Oak” includes White Oak, Chestnut Oak, Post Oak, Burr Oak, Swamp Chestnut Oak, Swamp White Oak, Live Oak, Chinquapin Oak, and other less known varieties of oak of this character.

The term “Red Oak” includes Red Oak, Black Oak, Southern Red Oak, Willow Oak, Water Oak, Pin Oak, Cherrybark, or Swamp Red Oak, and other less known varieties of oak of this character.

Southern Yellow Pine may be any species except Field or Loblolly.

818.06.02 Quality of White Oak or Red Oak. The Engineer will not approve wood for use that has splits, rot, or unsound knots. Use only pieces that are sawed full to specified sizes and lengths, with square edges except wane (bark or the lack of wood) as follows. The Engineer will allow wane on one corner on 30 percent of the pieces in any shipment, not to exceed 15 percent of the width of the face on which it appears. The Engineer will allow this grade with sound stains, scattered worm holes or grub holes not materially affecting the strength of the piece and sound bird pecks, or their equivalent; sound knots or their equivalent not exceeding in diameter 25 percent the width of the face

in which they appear. Use only boxed heartcenter wood products. Cut pieces not large enough to box the heartcenter outside the heart except that sizes 2 to 6 inches in thickness, 6 inches wide and wider, may show heart on one face only, in 30 percent of the pieces in any shipment.

818.06.03 Quality of Southern Yellow Pine. Conform to the SPIB grades as follows:

A) Structural Light Framing (2-inch by 2-inch to 4-inch by 4-inch). Provide No. 1 Dense.
B) Structural Joists and Planks (3-inch by 8-inch or 4-inch by 6-inch). Provide No. 1 Dense.
C) Stress Rated Timbers (5-inch by 5-inch and larger). Provide No. 1 SR.

818.06.04 Dimensions and Tolerances. Use rough timber that is cut full size as specified, sawed true with parallel faces. The Engineer will allow no more than 25 percent of a lot or shipment to be scant 1/4 inch in thickness and no more than 10 percent of a lot or shipment may be scant 1/4 inch in width.

Ensure that dressed dimensions for both oak and pine material conform to Southern Pine Inspection Bureau thicknesses and widths for Dimension Lumber.

818.06.05 Rough Local Hardwood. This subsection covers hardwood lumber and timber that is produced locally. Use only White Oak, Red Oak, or Beech hardwood. Where hardwood material is intended to be used inside, the Department will allow other species of hardwood, that are suitable for the intended use, when such species are specified.

1) Use only material that is cut from live standing trees and is free from any form of decay.
2) The Department does not require seasoned material.
3) Cut all pieces to a square edge with no less than 75 percent heart, girth measurement, for full length of the piece.
4) Saw all material to the full nominal dimensions.
5) Ensure that all knots are tight and sound. Do not allow any material with a knot of greater diameter than half of the width of the face on which it occurs. Allow only one maximum knot, or small knots aggregating in diameter of one maximum knot, in each one-foot length of timber.
6) Ensure that all material is reasonably free from crook and warp.
7) Do not allow any piece that has a shake, crack, or split which extends over half through the narrow face of the piece.
8) Do not allow any boxed heart in pieces less than 3 inches in thickness.
9) The Engineer will reject material having any defect or combination of defects that seriously impairs the strength or that renders it unsatisfactory for the intended use.

818.07 PRESERVATIVE TREATMENT. When the Contract specifies preservative treatment of wood products, treat according to AWPA C14. Provide preservative conforming to AWPA C14 as the Contract specifies.

Do not use creosote or creosote solutions with wood required to be paintable.

When the Contract specifies pentachlorophenol preservative, use heavy petroleum solvent when the Contract does not require painting. Use light petroleum solvent when the Contract requires that the wood is to be paintable.

Do not use water-borne preservatives where the wood will be in contact with water unless recommended by AWPA specifications.

Follow the guidelines set in AWPA M4 for the care of preservative treated wood products.

SECTION 819 —TUNNEL LINING MATERIALS

819.01 DESCRIPTION. This section covers materials requirements for steel plates and fittings to be used for lining tunnels. Refer to the Contract for sectional properties.

819.01.01 Steel Plates. Use base metal for steel plates that conforms to the chemical requirements of ASTM A 569. Ensure that the flat plate, before cold forming, conforms to the following minimum mechanical properties:

Tensile Strength	42,000 psi
Yield Strength	28,000 psi
Elongation, 2 inches	30%

Ensure that nominal plate dimensions provide the sectional properties shown in the current edition of the AASHTO Standard Specifications for Highway Bridges. For thickness tolerances, conform to Paragraph 14 of AASHTO M 167. Provide steel liner plates of additional thickness or protect by coatings or other means when specified in the Contract for resistance to abrasion or corrosion.

819.01.02 Bolts and Nuts. Do not use any bolts and nuts with lapped seams that are less than 5/8 inch in diameter. Provide bolts conforming to ASTM A 449 for plate thicknesses equal to or greater than 0.209 inch and A 307 for plate thickness less than 0.209 inch. Provide nuts conforming to ASTM A 307, Grade A.

Only use bolts and nuts with 4-flanged plates of no less than 1/2 inch in diameter for plate thicknesses to and including 0.179 inch and no less than 5/8 inch in diameter for plates of greater thickness.

SECTION 820 — TIMBER POLES

820.01 REQUIREMENTS. Provide poles of Southern Pine conforming to ANSI Specification 05.1. Provide poles of the length and ANSI size classification specified in the Contract. The Department will not allow sweep exceeding one inch in 10 feet or double sweep.

Treat poles with pentachlorophenol conforming to AWPA P8 according to AWPA C4. Treat with a light petroleum solvent to provide an oil-free paintable finished product. The Engineer will allow other processes which produce the specified paintability.

Ensure that net retention is no less than 0.075 pounds per cubic foot on the outer 1/2-inch and no less than 0.045 pounds per cubic foot in the 1/2 to one-inch zone with average retentions of no less than 0.080 and 0.050 pounds per cubic foot, respectively.

Follow the guidelines for the care of preservative treated wood products as set in AWPA M4.

820.02 ACCEPTANCE. The Department will inspect, test and accept poles according to Subsection 818.01.

SECTION 821 — BRIDGE COATINGS

821.01 DESCRIPTION. This section covers requirements for paints used in steel bridge construction and maintenance.

821.02 GENERAL REQUIREMENTS. Use only paint components that are factory mixed and delivered ready for use. Sediment formed during shipment must be easily dispersed with a paddle to produce a smooth, uniform coating having good spreading characteristics. Reject paint that excessively gels, or cakes in the container.

Ensure that the paint will produce a smooth uniform finish without sags or streaks. Use Federal Standard No. 141, Methods 4321 and 4331 to test the paints for finish characteristics. Ensure that batches of paint used on an individual structure do not differ in color from each other.

Store paint at temperatures above 32 °F and below the maximum temperature recommended by the coating manufacturer. The Engineer will reject or retest paint exposed to temperatures outside this range.

821.03 SAMPLING AND TESTING. Apply no paint until the Division of Materials has approved it. The Department will sample the material before, or after, delivery to the project. Allow the Department 10 calendar days to test and approve samples. Retest paint that is not used within its specified approval period. Remove rejected paint from the job site before starting painting operations.

Use paint conforming to this section and on the Department's List of Approved Materials. For a manufacturer to place their paint on the list, submit a verifiable field performance history and a certified test report from an approved independent testing laboratory showing specific test results conforming to all requirements of this section. The Department will accept independent laboratory testing completed within 2 years of the submittal date. Send the certified report and a one-gallon sample kit for testing by the Department. For zinc rich primers, include a separate one-quart sample of zinc dust. Upon approval by the Department, the Department will add the material to the List of Approved Materials. The Department requires new certified test results and samples for analysis when the manufacturing process or the coating formulation is changed or when testing indicates nonconformity with the specified requirements.

The Department will remove the product from the List of Approved Materials if it does not produce uniform results, does not consistently comply with this section, or does not produce an acceptable and durable coating.

821.04 ZINC RICH PRIMER COAT.

821.04.01 Composition.

A) Zinc Dust. Conform to ASTM D520 Type II with average particle size of 4-9 μm.

B) Base Component. Formulate with a solvent system compatible with its intended use. With organic systems, or paints applied to less than a SSPC-SP 10 blast cleaned surface, require compatibility between the base components and all materials, such as paint or mill scale, on the existing steel surface.

821.04.02 Properties of Mixed Coating.

MINIMUM REQUIREMENTS			
Characteristic	Inorganic	Organic	ASTM
Total Solids (% by weight of coating)	78	70	D 2369
Pigment (% by weight of total solids)	85	83	D 2371
Metallic zinc (% by weight of pigment)	87	93	D 521
Metallic zinc (% by weight of total solids)	74	77	D 521

A) Volatile Organic Content. 3.75 pounds per gallon maximum.
B) Water Tolerance. Ensure that water contamination up to one percent by weight will not cause the coating to gel within 5 minutes.
C) Color. Distinct contrast with the cleaned metal surface and with the top coat.
D) Usable Pot Life. A minimum of 4 hours at 70 °F and 50 percent relative humidity.

821.04.03 Field History. Provide certified documentation that the proposed coating has performed successfully on at least 10 projects for a minimum of 2 years. Include the name, address, and telephone number of the proprietary agency (including the name of a responsible contact person), the location of each structure involved, and the beginning and ending dates of each coating application.

821.05 MOISTURE CURE ALUMINUM POLYURETHANE INTERMEDIATE COAT.

821.05.01 Composition.

A) Pigment. Use a pigment containing a non-leafing aluminum. Ensure the dry whole paint contains 26 ± 2 percent aluminum by weight.
B) Vehicle. Use a one-component intermediate coat that cures by reaction with the atmospheric moisture. Formulate with a moisture cure polyisocyanate diphenylmethane diisocyanate based prepolymer with an isocyanate content of 16.0 to 17.0 percent by weight, an NCO equivalent weight of 247 to 263, and a viscosity of 1400 ± 200 cps at 77 °F.

821.05.02 Properties of Mixed Coating.

A) Total Solids by Weight of Coating. 69 ± 2.0 percent by weight according to ASTM D 2369 using a 4 hour dry time plus a one hour oven dry at 230 °F.
B) Viscosity. The manufacturer will supply a sample for qualifying purposes. Ensure the material at the project does not vary more than ± 10 KU from the qualifying sample.
C) Density. 9.5 ± 0.2 pounds per gallon.
D) Isocyanate Content. 9.6 ± 0.9 percent by weight according to KM 64-250.
E) Recoat Window. Provide a coating with a recoat window of at least 5 days for the application of the moisture cure intermediate coat and the acrylic polyurethane finish coat.
F) Volatile Organic Content. 2.8 pounds per gallon maximum as applied.
G) Single Coat. Will not run or sag when spray applied at 5 mils wet film thickness.

821.06 URETHANE FINISH COAT.

821.06.01 Composition. Use a two-component polyester or acrylic aliphatic urethane that conforms to the following physical requirements:

A) Resin. Formulate Component A with a hydroxyl bearing polyacrylic resin with a typical hydroxyl content of 4 percent and an average equivalent weight of 425 (both values at 100 percent resin solids). Ensure the resin makes up at least 95 percent of the polyol vehicle solids. Ensure Component A contains a hindered amine light stabilizer in the amount of one percent by weight of the combined Component A and B resin solids.
B) Curing Agent. Formulate Component B, the curing agent, with a polyisocyanate resin based on Hexamethylene diisocyanate with an NCO content of 21.0 to 22.0 percent and an average NCO equivalent weight of 195.

C) Specular Gloss.

1) Initial. 80 percent minimum at 60° angle of incidence according to ASTM D 523.
2) Retention. 70 percent minimum after weathering 24 months at 45° according to the South Florida Testing Service. As an alternate method, the Department will accept accelerated weathering data according to ASTM G 26, Type B, Method 2. Use cycles of 3.8 hours of light followed by one hour dark with a water spray during the dark cycle. Use a light source of 0.5 W/M^2 at 340 nanometers.

D) Rapid Chemical Resistance. The Department will test according to KM 64-256.

E) Total Solids. Minimum of 75 percent by weight according to ASTM D 2369 using a 4 hour dry time plus a one hour oven dry at 230 °F.

F) Color. The qualifying sample will conform to Federal Standard No. 595-36314. When aesthetic considerations for the project dictate a variation, submit samples for analysis and color comparison prior to supplying paint to the project.
The Department will use the manufacturer's qualifying sample as the control sample. Ensure the color of the mixed product supplied to the project does not vary more 1.0 ΔE_{cmc} from the control sample. Ensure the color of the field applied product does not vary more 1.5 ΔE_{cmc} from the control sample. The Department will obtain these values with a spectrophotometer using a D65 illuminant at 0° illumination with a 45° viewing angle and 2° observation angle.

G) Volatile Organic Content. 2.8 pounds per gallon maximum as applied.

821.06.02 Variation of Composition. The Department will test all project acceptance samples for conformance to the following physical and chemical tolerances on composition variance from the manufacturer's benchmark sample.

ALLOWABLE VARIATION		
	Variance	Method
Percent non-volatile	± 2.0%	ASTM D 3723
Percent pigment	± 2.0%	ASTM D 3723
Viscosity	± 10.0 KU	ASTM D 562
Weight per gallon	± 0.25 lb/gal	ASTM D 1475
Chemical composition of vehicle remains	essentially identical	IR spectroscopy
Chemical composition of volatile organic compounds remains	essentially identical	gas chromatograph

821.06.03 Packaging. Package in 2 containers and label them Part A and Part B. Package so that when Part A and Part B are mixed the yield is less than 5 gallons of mixed coating. Label each container clearly to show the manufacturer or brand name of the coating, the lot number, and the date of manufacture. Include complete instructions on the label of one container or send separate written instructions with each shipment.

821.07 APPROVAL REQUIREMENTS.

821.07.01 Product Data Sheets. Supply a Manufacturer's Product Data Sheet which provides the following information:

A) Volatile Organic Compound (VOC).

1) VOC supplied in the container for single component materials.

2) VOC for multiple component systems when supplied containers are properly mixed.
3) The volume of the thinner that can be added to a single component material or mixed component materials and not exceed 3.75 pounds per gallon of VOC for the zinc primer and 2.8 pounds per gallon for the intermediate and finish coats.

B) Properties of Mixed Materials.

1) Total percent solids by weight.
2) Percent pigment by weight.
3) Total solids by volume according to ASTM D 2697.
4) Percent metallic zinc in the dried film.
5) Weight per gallon.
6) Viscosity in Krebs units. (Stormer at 77 °F).
7) Pot life in hours, at a specified temperature and humidity.
8) Lenata (Sag resistance) in mils wet film thickness.
9) Recommended minimum and maximum dry film thickness in mils. Report the dry film thicknesses as the thickness of the coating to the top surface of the profile peaks.
10) Minimum drying time at 77 °F and 50 percent relative humidity. Include touch dry, handling, and recoat. If applicable, include a maximum recoat window.
11) Mix ratios for multi-component paints.
12) Shelf life of each component stored at 77 °F.

C) Independent Laboratory Reports. Supply test reports with the following information:

1) Name of the testing firm(s) preparing the report and the date the report is prepared.
2) Name of the coatings' manufacturer and the trade name of the coating tested.
3) Notarized "Certificate of Compliance". Include a statement by the testing firm stating that they tested the products according to this section, the support specifications, and that all information presented is truthful and without bias. The manufacturer and testing firm will maintain all unsubmitted records and documents pertaining to the certificate for at least 7 years. The manufacturer's representative, the test supervisor, and the principal owner/manager of the testing firm will sign the certificate. These individuals will also include their name and title in typed or printed form.
4) Table of Contents.
5) Summary of all test results.
6) Individual test results of all panels tested.

821.07.02 Resistance Tests. Require for zinc rich primer, moisture cure aluminum polyurethane intermediate coat, and urethane finish.

A) Preparation. White metal blast clean (SSPC-SP 5), with a nominal anchor profile from 1.5 to 2.5 mils, both sides of steel test panels (ASTM A 36 hot rolled steel or equivalent) measuring 4 by 6 by 1/16 inches or greater.

1) Zinc Rich Primer Coat. Coat both sides with zinc rich primer. Protect the edges of the coated panels by applying electrical tape. The tape should not extend more than 0.2 inches onto the coated surface from the edge of the panel. Spray apply and cure the coating by the manufacturer's recommendations.

2) Moisture Cure Aluminum Polyurethane Intermediate Coat. Coat both sides with the zinc rich primer and moisture cure intermediate. Protect the edges of the coated panels by applying electrical tape. The tape should not extend more than 0.2 inches onto the coated surface from the edge of the panel. Spray apply and cure the coating by the manufacturer's recommendations.
3) Urethane Finish Coat. Coat both sides and all edges with the zinc rich primer, moisture cure intermediate, and urethane finish. Spray apply and cure the coating by the manufacturer's recommendations.

The dry film thickness shall be 2.5 to 3.5 mils of primer, with the manufacturer's recommended thickness of the moisture cure intermediate and urethane finish. Age the panels for 14 days at 75-79 °F and 45-55 percent relative humidity before any exposure testing. Perform tests on at least 3 panels. The average of the 3 test results will be the value reported for acceptance.

B) Fresh Water Resistance. Scribe panels down to base metal with an **X** with at least 2-inch legs and immerse in fresh tap water at 75 ± 5 °F. Examine the panel after 30 days, and verify that there is no rusting, blistering, or softening of the coated panels.

C) Salt Water Resistance. Scribe down to the base metal with an **X** with at least 2-inch legs and immerse in a 5 percent sodium chloride solution at 75 ± 5 °F. Examine the panel after 7, 14, and 30 days, and verify that there is no rusting, blistering, or softening of the coating. Replenish the sodium chloride solution with fresh solution after each examination.

D) Weathering Resistance. Perform an accelerated weathering resistance test according to ASTM G 53 [Standard Practice for Operating Light - and Water - Exposure Apparatus (Fluorescent UV - Condensation Type) for Exposure of Nonmetallic Materials]. Ultraviolet Region: use the UV-A radiation with a lamp having a peak of 340 nanometers and a range of 295 to 365 nanometers. Use the following time cycles: 8 hours UV at 158 ± 4 °F, alternating with 4 hours condensation at 122 ± 4 °F, and repeating.

Place the panels in the test cabinet at the beginning of the wet cycle and expose for a 4,000 hour duration. Evaluate Color Change according to ASTM D 2244. Perform color change procedures according to Section 6.2 CIE 1976 L*a*b.

Require no spontaneous delamination (evaluated subjectively) or blistering after exposure. Evaluate according to ASTM D 714. Ensure that rust creepage at the scribe is no greater than 6 mils and total rusting at the scribed edges is no more than 2 percent of the exposed face area according to ASTM D 1654, Method 2 (scraping). Ensure that the difference in color does not exceed a ΔE of 3.0.

The acceptance goal will be to meet the 4,000-hour limit. However, full evaluations will be performed at 2,000, 3,000, and 4,000 hours to determine the maximum acceptable limit for panels coated with primer/intermediate and primer/intermediate/finish coats for all resistance tests.

E) Relative Humidity Resistance. Perform according to ASTM D 2247 for 4,000 hours. Require no blistering, cracking, or delamination after exposure. Ensure that rust creepage at the scribe is no greater than 3 mils and total rusting at the scribed edges is no greater than 2 percent of the exposed face area, according to ASTM D 1654, Method 2 (scraping).

F) Salt Fog Resistance Test. Perform according to ASTM B 117 and evaluate at 4,000 and 5,000 hours. Require no spontaneous delamination (evaluated subjectively) or blistering after exposure. Evaluate according to ASTM D 714. Ensure that rust creepage at the scribe is no greater than 6 mils and total rusting at the scribed edges is no more than 2 percent of the exposed face area according to ASTM D 1654, Method 2 (scraping).

821.07.03 Slip Coefficient Test. When using zinc rich primer coats on new and

rehabilitated structures with painted connections designed for Class B allowable stress, conform to the Class B slip coefficient requirements specified in the AASHTO Standard Specifications for Highway Bridges. Provide test data from the supplier stating the compliance with this requirement as well as the cure time and the maximum allowable coating thickness according to the test.

821.08 PROJECT ACCEPTANCE. Submit a written manufacturer's certification with each shipment of paint stating that the material furnished conforms to this section. Submit a separate certification for each batch or lot number furnished for each project. Verify that the batch or lot of paint is approved by the Department before applying.

SECTION 822 — ELASTOMERIC BEARING PADS

822.01 ELASTOMERIC BEARING PADS. Furnish elastomeric bearing pads conforming to the design and dimensions as specified in the Plans and to the AASHTO Standard Specifications for Highway Bridges, Division II, Section 18.

Use bearings that are low temperature Grade 3 with durometer hardness of 50 and that conform to the load test requirements corresponding to Design Method A.

SECTION 823 — CONCRETE CURING MATERIALS

823.01 GENERAL. This section lists the various types of curing materials allowed for concrete and the materials requirements applicable to each. The Department will provide specifications governing the particular type or types of curing materials allowed for specific classes of construction in the Contract or other sections of these specifications.

823.02 LIQUID MEMBRANE FORMING COMPOUNDS. Ensure that all curing compounds Conform to AASHTO M 148 and are from a Department approved manufacturer.

1) Type 1-D (Clear with fugitive dye or translucent with fugitive dye), Class A or Class B.
2) Type 2 (White pigmented), Class A or Class B. Supply Type 2 curing compounds in agitating type drums, except the Department will not require agitating type containers when Type 2 curing compound is supplied in 5 gallon pails.

The Department will accept curing compounds on the basis of certification of their conformance to this section and their being from an approved manufacturer. The Department will reject curing compounds from an unapproved manufacturer and require their removal from the project site.

823.01.02 Acceptance Procedures for Non-Specification Curing Compounds. The Department will test project samples. When non-specification curing compounds are inadvertently incorporated into the work the Department will accept the material with a reduction in pay. The Department will apply the largest payment reduction when the material fails to meet more than one specification requirement. The Department will calculate the payment reduction on the invoice cost of the material delivered at the project site.

MOISTURE LOSS PAYMENT REDUCTION				
kg/square meter	0.00-0.55	0.56-0.65	0.66-0.75	0.76 or more
Reduction Rate	0%	20%	30%	50%

REFLECTANCE PAYMENT REDUCTION				
% Reflectance	60.0% or more	50-59.9%	40.0-49.9%	39.9% or less
Reduction Rate	0%	20%	30%	50%

823.03 BURLAP CLOTH. Conform to AASHTO M 182, Class 4.

823.04 WATERPROOF PAPER (Regular or White). Conform to AASHTO M 171.

823.05 WHITE POLYETHYLENE FILM (White Opaque). Use white polyethylene film of either single sheet construction conforming to AASHTO M 171 or laminated construction consisting of 2 sheets of white polyethylene reinforced with synthetic fiber cords, providing the total thickness of polyethylene, exclusive of the cords, averages no less than 4 mils and the sheeting conforms to all other applicable requirements of AASHTO M 171. Incorporate the reinforcing cords diagonally in 2 directions and ensure that the number of cords averages 24 per linear foot in each direction.

823.06 WHITE BURLAP - POLYETHYLENE SHEET. Conform to AASHTO M 171.

823.07 CURING BLANKETS. Use curing blankets that consist of a top layer of white copolymer material and a bottom layer of absorbent, non-woven, synthetic fabric. Ensure that the layers are securely bonded together so there will be no separation of the layers during handling and curing of the concrete. When tested according to AASHTO M 171, ensure that moisture loss does not exceed 0.010grams per square centimeter and that reflectance is at least 70 percent.

SECTION 824 — MASONRY MATERIALS

824.01 CONCRETE MASONRY UNITS (FOR CONSTRUCTION OF CATCH BASINS AND MANHOLES). Conform to ASTM C 139.

824.02 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS. Conform to Subsection 710.02.13.

824.03 CONCRETE BRICK. Conform to ASTM C 55. Use Type II, Grade N or S.

824.04 SEWER AND MANHOLE LEVELING BRICK. Conform to AASHTO M 91. The Department will waive the requirement for saturation coefficient for Grades SM and MS. Ensure that the dimensions are of the specified standard size.

824.04.01 Sewer Brick. Use Grade SS or SM.

824.04.02 Manhole Brick. Use Grade MS or MM.

824.05 HYDRATED LIME. Conform to ASTM C 206.

SECTION 825 — DE-ICERS

825.01 SOLID (TYPE S) CALCIUM CHLORIDE. Conform to ASTM D 98 for the following:

A) Grade 1. Class A or Class B.
B) Grade 2. Class A or Class B.
C) Grade 3. Class A or Class B.

825.02 SODIUM CHLORIDE. Conform to ASTM D 632, Type I, Grade 1.

SECTION 826 — EPOXY RESIN SYSTEMS

826.01 GENERAL. Conform to ASTM C 881, except as specified in Subsections 826.01.01 and 826.01.02. Provide materials, of all types, of the Grade and Class required. Types are as follows:

A) Type III. Use in epoxy-sand slurry, as a binder in epoxy mortars or epoxy concretes.
B) Type IV. Use for installing dowels into hardened portland cement concrete.
C) Type V. Use for bonding plastic portland cement concrete to hardened portland cement concrete.

826.01.01 Epoxy-Sand Slurry for Concrete Bridge Deck Overlays. Conform to ASTM C 881, Type III or AASHTO M 200, Class II.

826.01.02 Reinforcing Bar Grout Adhesives. The Department will allow reinforcing bar grout adhesives, from the Department's List of Approved Materials, as an alternate to Type IV epoxies for doweling reinforcing bars into hardened concrete.

826.02 APPROVAL. The Department will approve ASTM C 881 epoxies based on the manufacturer's submission of independent laboratory data showing the actual test values for all of the ASTM specification requirements. The Department will test reinforcing bar grout adhesives according to KM 64-209.

826.03 PACKAGING. Package the 2 components in separate containers. Identify the containers as "Component A - Contains Epoxy Resin" and "Component B - Contains Hardener." Include on the container the following information:

1) Type, mixing directions, and usable temperature range.
2) Name of the Manufacturer.
3) Lot or batch number.
4) Date of packaging.
5) Type of pigmentation.
6) Quantity contained in pounds and gallons.
7) Potential hazards according to the Federal Hazardous Products Labeling Act.

826.04 ACCEPTANCE. The Department will accept the materials based on the sampling and testing performed according to the Department's Manual of Field Sampling and Testing Practices.

SECTION 827 — EROSION CONTROL MATERIALS

827.01 DESCRIPTION. This section covers the requirements for various materials used for erosion control.

827.02 AGRICULTURAL LIMESTONE. Conform to the requirements and provisions of the Kentucky Department of Agriculture. The Department of Agriculture furnishes a test report and any required weight penalties to each agricultural limestone producer. Furnish the Engineer with a copy of the test report, current within 9 months, as the basis of approval. The Engineer may sample any agricultural limestone that appears to be of questionable quality upon visual inspection.

827.03 FERTILIZER. Provide commercial fertilizer that complies with the Kentucky Fertilizer Law, and contains the plant nutrients of nitrogen, available phosphoric acid, and soluble potash as specified in the Contract. Ensure that bagged fertilizer displays the following information on the bag or on a sticker or tag attached to the bag:

1) Net Weight
2) Brand and Grade
3) Guaranteed Analysis
4) Name and Address of Manufacturer

Ensure that the manufacturer includes a statement with the bulk fertilizer (dry or liquid) that contains the same information required for the bagged fertilizer.

Provide either bagged or bulk (dry or liquid) fertilizer manufactured and sold under the jurisdiction of the Division of Regulatory Services of the University of Kentucky Agricultural Experiment Station. Select a supplier from the Department's List of Approved Materials for fertilizer. The Department must sample, test, and approve any other fertilizer prior to its use.

827.04 SEED. Do not use seed that contains more than 1.0 percent weed seeds by weight. Ensure that the noxious weed seeds contained in any seed does not exceed the maximum number specified in the following listing:

Noxious Weeds	Max. No. Seeds (per ounce)
Johnson Grass (Sorghum halepense)	0
Giant Foxtail (Setaria fabrii)	3
Canada Thistle (Cirsium arvense)	0
Wild Onion (Allium vineale)	3
Nodding Thistle (Carduus nutans)	0
Buckhorn (Plantago canceolata)	9
Corncockle (Agrostemna quithago)	9
Dodder (Cuscuta sp.)	9
Oxeye Daisy (Chrysanthemum leucanthemum)	9
Quack Grass (Agropyron repens)	0
Sorrel (Rumex acetosella)	15

Conform to the applicable minimum purity and actual germination percentages specified in the table, Requirements for Seeds, with no tolerances below the minimum percentages. Do not use seed later than 9 months after testing, exclusive of the month testing was completed.

The Department will sample and test all seed, exclusive of seed used for temporary seeding and protection, either before or after delivery to the project. If requested, the Department will sample and test seed for a seed vendor who supplies seed for use on highway projects and who agrees to comply with all of the following requirements:

1) Select, set aside, and provide easy access to at least a total of 10,000 pounds of one or more kinds of seed each time a request is made for pretesting.
2) Provide the necessary labor to assist the Engineer in handling the seed packages or bags during sampling and tagging.
3) Reserve the quantity of seed pretested in storage until authorized by the Department to dispose of the seed for purposes other than highway uses.
4) Preserve and leave attached, all tags and labels attached by the Engineer, unless the Department authorizes to remove them.
5) Cooperate with and aid the Engineer in a manner that will expedite the pretesting operations.

Do not sow any seed until the Engineer receives verification that the seed complies with all specified requirements. The Engineer may obtain proper verification by one of the following methods:

A) Pretesting Method. If seed arrives to the project with tags or seals or other methods of identification affixed to the bag, the Department has pretested the seed. The Engineer will verify that the seed conforms to the specified requirements and that the approval period has not expired.

B) Project Sampling Method. The Engineer will take samples and submit them to the Division of Materials for testing. Allow the Division of Materials 5 weeks to provide test reports indicating that the samples conform to the specified requirements.

REQUIREMENTS FOR SEEDS				
	Grasses	Purity (Min. %)	Germination (Min. %) Including Hard Seed	Hard Seed (Max.%) Allowed in Germination
	Bentgrass (Argrostic palustris)	98	80	-
C	Bermudagrass, common (Cynodon dactylon)	95	80	-
H	Bluegrass, Kentucky (Poa pratensis)	90	80	-
A	Brome, smooth (Bromus inermis)	85	80	-
F	Canarygrass, reed (Phalaris arundinacea)	90	80	-
F	Fescue, Chewings (Festuca rubra var. commutata)	95	80	-
Y	Fescue, meadow (Festuca elatior)	96	85	-
	Fescue, red (Festuca rubra)	95	85	-
S	Fescue, tall (Festuca arundinacca)	95	85	-
E	Orchardgrass (Dactylis glomerata)	85	80	-
E	Redtop (Agrostic alba)	90	80	-
D	Ryegrass, annual, common or Italian (Lotium multiflorum)	97	85	-
S	Ryegrass, perennial (Lolium perenne)	95	85	-
	Lovegrass, Weeping (Eragrostic curvula)	96	75	-
N	Oat (Avena Sativa)	96	80	-
O	Rye (Secale cereale)	96	80	-
N	Timothy (Phleum pratense)	98	80	-
C	Wheat, common (Triticum aestivum)	96	80	-
H	Legumes			
A	Alfalfa (Medicago sativa)	98	85	30
F	Clover, alsike (Trifolium hybridum)	96	80	35
F	Clover, ladino (Trifolium repens)	97	80	35
Y	Clover, white (Trifolium repens)	96	80	35
	Crownvetch (Coronilla varia)	96	80	30
S	Lespedeza, Korean (Lespedeza stipulacea)	97	80	25
E	Lespedeza, Sevicea (Lespedeza cuneata)	97	80	25
E	Sweetclover, white (Melilotus alba)	97	85	30
D	Sweetclover, yellow (Melilotus officinalis)	97	85	30
S	Trefoil, birdsfoot (Lotus corniculatus)	97	80	35

827.05 MULCH MATERIALS. Use material for mulching that is baled wheat, oat, barley, or rye straw, or excelsior wood fibers. Ensure that mulch material is reasonably free from weed seeds, stolons, foreign matter, or chaff, and does not contain any Johnson Grass, Canada Thistle, Quack Grass, or Nodding Thistle. Ensure that the mulch material is reasonably bright in color and not musty, moldy, or otherwise of low quality, and does not contain chemicals toxic to plant growth.

Use excelsior wood fibers that consist of fibers cut from sound green timber. Ensure that the cut is made in a manner to provide maximum strength of fiber, but is at a slight angle to the natural grain of the wood so as to cause splintering of the fiber when weathering occurs. Use fibers with the following approximate physical properties: width 0.02 to 0.04 inch, thickness 0.02 to 0.04 inch, and length 4 to 6 inches.

827.06 ASPHALT MATERIALS FOR MULCH. Use either SS-1, SS-1h, Primer L, AE-60, MC-30, or MC-70, all conforming to Section 806 except that the Department may waive retesting as provided by Subsection 806.04. The Engineer may reject asphalt materials that fail to disperse properly or otherwise fail to provide satisfactory results.

827.07 EROSION CONTROL BLANKET. Use a machine constructed curled wood fiber mat with two-sided netting. Ensure the blanket is smolder resistant without the use of chemical additives.

A) Dimensions. Furnish in strips either 4 or 8 feet wide and at least 50 feet long.
B) Weight. Ensure the blanket weighs between 0.98 and 1.5 pounds per square yard.
C) Fill. Use curled wood fiber of consistent thickness with at least 80 percent of its fibers 6 inches or longer in length. Ensure the fibers are evenly distributed throughout the blanket.
D) Netting. Use photodegradable extruded plastic mesh or netting, with a maximum spacing width of one inch square, on both sides of the blanket. Secure the netting by stitching or other method to ensure the blanket retains its integrity.
E) Staples. Use steel wire U-shaped staples with a minimum diameter of 0.09 inches (11 gauge), a minimum width of one inch, and a minimum length of 6 inches. Use a heavier gauge when working in rocky or clay soils and longer lengths in sandy soils.

827.08 TEMPORARY SILT FENCE.

A) Posts. Use either hardwood or steel greater than 4 feet in height. For hardwood, provide a minimum 1 1/2-inch by 1 1/2-inch cross section that is straight enough to provide a fence without noticeable misalignment. For steel, provide a 1 1/4- inch by one-inch T-section with projections to fasten wire and fabric in position.
B) Woven or Welded Wire Fabric. Conform to Section 816 or 811. Provide fabric with a minimum height of 2 feet 8 inches. Require at least 6 horizontal wires spaced 6 1/4 inches or closer with the top and bottom wires 0.134 inch or larger and all other wires 0.1 inch or larger. Require 0.1 inch or larger vertical wires spaced 12 inches or closer.
C) Geotextile Fabric. Conform to AASHTO M 288 for temporary silt fence. Provide fabric with a height of 3 feet.
D) Fasteners. Use No. 9, one inch long wire staples and/or fabric ties that conform to Subsection 816.06.

827.09 NETTING AND STAPLES. Conform to the Standard Drawings and the Plans. The Engineer may accept netting and staples on the basis of visual inspection.

827.10 TOPSOIL. Topsoil is the portion of the soil profile defined technically as the "A" horizon by the Soil Science Society of America. Use loose, friable, topsoil that is free of stones 1 inch or greater in overall dimensions, admixture of subsoil, refuse, stumps, roots, brush, weeds, and other material that prevent the formation of a suitable seed bed. Before stripping the topsoil, inspect for existing vegetation. Do not use topsoil from sites having Johnson Grass, Canada Thistle, Quack Grass, Nodding Thistle, or excessive amounts of other noxious weeds, or their rhizomes. The Department will sample the soil and determine the textural classification according to the US Department of Agriculture system, the particle size according to KM 64-519, the organic content according to KM 64-243, and the pH according to ASTM D 4972. Acceptable topsoil composition is:

Clay	40% maximum
Silt	70% maximum
Sand	60% maximum
Organic Material	2% minimum, 10% maximum
pH	6.0 minimum, 7.0 maximum

827.11 SOD. Use sod that is either well-rooted Kentucky Bluegrass or Tall Fescue sod. However, obtain the Engineer's approval prior to using Tall Fescue sod in residential areas. Use sod that is completely free from noxious weeds and reasonably free from other objectionable grasses and weeds and stones or other foreign materials detrimental to the

development and future maintenance of the sod. Obtain sod from sources that are covered with grass having a maximum height of 3 inches. Obtain approval of the selected source prior to cutting.

SECTION 828 — MASONRY COATING MATERIALS

828.01 DESCRIPTION. This section covers requirements for materials to be used as surface finishes for designated surfaces of cement concrete structures. The masonry coatings must hide form marks, patches, and other minor irregularities and prevent deterioration, spalling, and other damage to the concrete due to the action of the weather and deicing chemicals.

828.02 APPROVAL. Select masonry coatings from the Department's List of Approved Materials. Use a material that is readily recognizable by its name, trademark, container, or other feature. Conform to the Department's testing criteria to be placed on or remain on the Department's List of Approved Materials.

For initial approval submit representative samples, color chip(s), and duplicate copies of certified test reports to the Division of Materials for review and approval. An independent testing laboratory acceptable to the Department shall perform the tests described herein on representative samples of the material. Tests listed herein are the minimum testing requirements to be met. When requested in writing, the Engineer may accept materials based on conformance to the same type of test but differing on minor procedural points. Attach copies of test procedures which differ from those stated herein. In addition to the material, provide brochures or booklets containing detailed instructions and explanatory remarks about surface preparation, application procedures, and other pertinent operations.

828.02.01 Freeze-Thaw Test. Cast and cure 3 concrete specimens no less than 4 by 4 by 6 inches. Moist cure specimens for 14 days and then dry in room air at 60 to 80 °F for 24 hours before applying masonry coating. Ensure that there is no excessive oil on specimen forms. Coat sides of specimens (brush permitted) according to the manufacturer's directions at a rate of 50 ± 10 square feet per gallon and cure at room temperature for 48 hours; after which:

1) Immerse in water at room temperature 60 to 80 °F for 3 hours and remove.
2) Place in cold storage at -15 °F for one hour and remove.
3) Thaw at room temperature 60 to 80 °F for one hour.
4) Repeat steps 1), 2), and 3) to complete a total of 50 cycles. At the end of 50 cycles of the Freeze-Thaw Test, ensure that the coated specimens shows no visible defects.

828.02.02 Accelerated Weathering. Test according to ASTM D 822. Apply at an application rate of 50 ± 10 square feet per gallon. Test for 335 hours in an Atlas Type XW Sunshine Arc Weatherometer or for 500 hours in an Atlas Type DMC Enclosed Violet Carbon Arc Weatherometer or equivalent. Perform the test in 120-minute cycles consisting of 102 minutes of light and 18 minutes of light and demineralized water. At the end of the exposure test, ensure that there is no checking, cracking, or loss in film integrity, and no other film defects. Ensure that the coating shows no more than very slight color change.

828.02.03 Salt Spray Resistance. Apply the masonry coating to concrete at a rate of 50 ± 10 square feet per gallon, and test the coating according to ASTM B 117. Expose the coating to a 5 percent sodium (salt) solution for 300 hours, and maintain it at 90 ± 2 °F during the period of exposure. Ensure that it shows no loss of adhesion or deterioration at the end of the 300 hours.

828.02.04 Fungus Growth Resistance. Ensure that the masonry coating passes a fungus resistance test as described by Federal Specification TT-P-29. After a minimum incubation period of 21 days, ensure that no growth is exhibited on the coating.

SECTION 829 —HARDWARE FOR TIMBER STRUCTURES

829.01 GENERAL. Use only black nails, spikes, bolts, dowels, washers, and lag screws.

829.02 BOLTS. Use machine bolts having square heads and nuts, and ensure that screw threads make a close fit in the nuts. Furnish machine bolts, drift-bolts, and dowels of either wrought iron or medium steel. Designate the weight of bolts as "American Standard Regular."

829.03 WASHERS. Furnish washers that either are cast O-gee or malleable castings or are cut from medium steel or wrought-iron plate, as specified in the Contract.

829.04 NAILS. For nails, use cut or round wire of standard form. Furnish cut or wire spikes, or boat spikes, as specified in the Contract.

SECTION 830 — RETROREFLECTIVE MATERIALS

830.01 DESCRIPTION. This section covers the requirements for retroreflective materials for use in delineators, barricades, traffic drum channelizing tapes, cone collars, signs, and for other applications as required.

830.02 GENERAL REQUIREMENTS. Use retroreflective materials that exhibit a daylight appearance unaffected by viewing angle. Use materials that exhibit the same color and appearance at night under directional lighting as in daylight. Ensure that all materials and prepared sign faces are free from cracks, tears, ridges, humps, discoloration, or other objectionable blemishes. Use material that is resistant to the formation of appreciable fungus growth. When furnishing materials for the Department or its agent to fabricate signs, ensure compatibility with the manufacturer's recommended fabrication procedures and the requirements of this section. The Department will reject material that prevents successful fabrication.

830.02.01 Delineators. Provide the size and shape specified in the Contract. Use delineator units that are readily attachable to mounting posts.

Provide delineators that exhibit no significant change in shape or appearance when subjected to the heat resistance test.

Provide delineators that exhibit the following minimum specific reflectivity:

MINIMUM COEFFCIENT OF RETROFLECTION R[1] (Candelas per lux per meter squared)			
Observation Angle	Entrance Angle	White	Yellow
+ 0.1	0	119	71
+ 0.1	+ 20	47	28
+ 0.33	0	20	12
+ 0.33	+ 20	8	5

A) Type A. Furnish a plastic prismatic retroreflective optical system forming a single reflectorized surface. Provide units that are completely sealed against dust, water, and water vapor in a non-corrosive metal-backed housing and exhibit no water intake when subjected to the seal test. Provide screw-on or bolt-on demountable units.

B) Type B. Furnish Type III, Class 1 retroreflective sheeting attached to a non-corrosive metal backing.

C) Type C. Furnish Type III, Class 1 retroreflective sheeting attached to flexible delineator posts.

830.02.02 Barricade Sheeting. Conform to ASTM D 4956, Type III, Class 1.

830.02.03 Traffic Drum Channelizing Tape. Conform to ASTM D 4956, Type III, Class 1 or 3.

830.02.04 Cone Collars. Conform to ASTM D 4956, Type III or Type VI, Class 1 or 3.

830.02.05 Retroreflective Sheeting. Furnish either Type III or Wide Angle Prismatic (WAP) as specified in the Contract. Use sheeting materials that present a finished surface suitable for receiving stenciled messages or paint overlays.

Provide only retroreflective sign sheeting materials that conform to Federal Specification L-S-300C for solvent resistance, heat resistance, cold resistance, and humidity resistance.

A) Type III. Conform to ASTM D 4956.

B) WAP. Use 3M Diamond Grade sheeting, Series 3924 for fluorescent orange and 3970 for all other colors, or Department approved equal. Conform to the following retroreflectivity requirements:

MINIMUM COEFFICIENT OF RETROFLECTION R[1]
(Candelas per lux per meter squared)
(0.2° Observation and -4° Entrance Angle at 0° and 90° Orientation)

Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	Fluor-Orange
0.2	-4	800	660	80	215	43	200
0.2	+30	400	340	35	100	20	120
0.2	+45	145	85	12	25	7.6	-
0.2	+60	35	23	2.0	6.6	1.0	50
0.5	-4	200	160	20	45	9.8	80
0.5	+30	100	85	10	26	5.0	50
0.5	+45	75	60	6.0	18	2.8	-
0.5	+60	30	20	2.0	6.4	2.0	20

**Measure the 60^o entrance angle at 90^o orientation only.*

830.03 FIELD PERFORMANCE. The using agency is responsible for requiring the dating of all signs at the time of application. The Department will begin the field performance obligation period based on that date.

The Department will consider the retroreflective sheeting defective if it has deteriorated due to natural causes to the extent that the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions or when the sign does not conform to the following tables:

MINIMUM COEFFICIENT OF RETROREFLECTIVE R[1]
TEN YEAR PERFORMANCE
(Candelas per lux per meter squared)
(0.2° Observation and -4° Entrance Angle)

Color	Type III
White	200
Yellow	136
Red	36
Green	36
Blue	16
Brown	8

MINIMUM COEFFICIENT OF RETROREFLECTIVE R[1] SEVEN YEAR PERFORMANCE (Candelas per lux per meter squared) (0.2° Observation and -4° Entrance Angle)		
Color	Type III	WAP
White	212	400
Yellow	144	330
Red	38	107
Green	38	40
Blue	17	22
Brown	10	—

MINIMUM COEFFICIENT OF RETROREFLECTIVE R[1] THREE YEAR PERFORMANCE (Candelas per lux per meter squared) (0.2° Observation and -4° Entrance Angle)		
Color	Type III	WAP
Fluorescent Orange	—	100
Orange	96	—

For screen printed transparent colored areas on white sheeting, ensure that the coefficients of retroreflection are not less than 50 percent for Type III and 70 percent for WAP of the values for the corresponding color in the above tables.

Make all measurements after cleaning the sign according to the manufacturer's recommendations.

830.04 WARRANTY. When the Engineer determines that the retroreflective traffic control devices supplied and used according to the manufacturer's recommendations have not met field performance requirements, the manufacturer shall cover restoration costs as follows for Type III and WAP sheeting:

1) White, Yellow, Red, Green, Blue, and Brown. Within the first 7 years after application, replace the sheeting and cover the cost of materials and labor required to restore the sign surface to its original effectiveness. Within the 8th through 10th year after application, replace the sheeting required to restore the sign surface to its original effectiveness.
2) Orange and Fluorescent Orange. Within 3 years after application, replace the sheeting required to restore the sign to its original effectiveness.

830.05 PACKAGING. Ensure that all materials are suitably and substantially packaged and have the name and address of the manufacturer or vendor, contract or purchase order number, kind of material, trade name, date of manufacture, lot and run number, color, and net contents plainly marked on each package or container. Ensure that if stored under normal conditions, the retroreflective material as furnished is suitable for use for a minimum period of one year.

830.06 SAMPLING. For the purpose of sampling, a shipment consists of the amount of material received in one delivery even though it may represent only partial delivery of the Contract quantities. The Department will sample according to the Manual for Field Sampling and Testing.

830.07 TESTING AND ACCEPTANCE. Furnish copies of actual passing test reports for retroreflective sheeting. Provide certifications from the sign supplier that the material furnished is the same represented by the test reports.

Use only retroreflective sign sheeting, barricade sheeting, traffic drum channelizing tape, and cone collars that have approved list status.

SECTION 831 — CONSTRUCTION ZONE TEMPORARY MARKING TAPES

831.01 DESCRIPTION. This section covers pavement marking material designed to provide reflective delineation in construction zones. This section covers the following types of marking material:

A) Type A. Non-removable Pavement Marking Tape.
B) Type B. Removable Pavement Marking Tape.

831.02 REQUIREMENTS.

831.02.01 Manufacture. Use a material consisting of a weather and traffic-resistant reflective film on a backing precoated with a pressure-sensitive adhesive.

831.02.02 Adhesive. Use a precoated pressure-sensitive adhesive that does not require a liner or activation.

831.02.03 Application Properties. Ensure that the material adheres to asphalt and concrete surfaces, when applied according to the manufacturer's recommendations, at or above surface temperatures of 40 °F. Ensure that the material does not require any protective devices such as traffic cones or barricades after application.

831.02.04 Conformability and Thickness. Use material that is thin, flexible, formable, and remains conformed to the texture of the pavement surface following application. Ensure that the thickness of the material furnished is within 2 mils of the thickness of the material submitted for initial testing for placement on the Department's List of Approved Materials. Use tape with a minimum width of 4 inches.

831.02.05 Miscellaneous Requirements. Ensure that the supplied material is of good appearance, free from cracks, with edges true, straight, and unbroken. Make the material available in rolls with no more than 3 splices per 50 yards of length. Package the material according to accepted commercial standards. Ensure that the supplied material is capable of being stored at temperatures up to 100 °F for a period of one year after purchase without adversely affecting the physical properties stated in this section.

831.02.06 Performance. The AASHTO Regional Test Facility and the National Transportation Product Evaluation Program will perform field performance testing. They will perform testing at approximately one year intervals, and will require a 6 month minimum testing period. Procedures will be according to the AASHTO Regional Test Facility and the National Transportation Product Evaluation Program. They will evaluate all tapes on both asphalt and PCC pavement. The performance criteria is included in the Department's List of Approved Materials.

831.03 APPROVAL. Use materials that are on the Department's List of Approved Materials. To be placed on the approved list, tapes must conform to all requirements of this section. Ensure that each shipment of tape to a project is accompanied by a statement from the manufacturer indicating the brand or trade name of the tape. The Department reserves the right to sample and test materials actually furnished at any time.

The Department will remove materials from the list if the material fails to be acceptable in subsequent field performance testing or the material's composition has changed since the original approval.

SECTION 832 — SIGN POSTS

832.01 GENERAL. Furnish Type I and II posts. Type I posts are square tubular posts. Type II posts are channels. Provide all posts in lengths as specified in one foot increments with a tolerance of ± 1 inch. The Department may require anchor plates for either type.

Ensure that posts are straight, smooth, and free from any defects affecting their strength, durability, or appearance. Ensure that all holes and ends are free from burrs and sharp edges and that ends are cut square.

832.02 TYPE I POSTS. Use hot rolled carbon sheet steel of structural quality that conforms to ASTM A 570, Grade 50. Yield strength after cold-forming is 60,000 psi minimum.

832.02.01 Fabrication. Fabricate the post from square tube formed of steel, rolled to size and welded directly in the corner by high frequency resistance welding and externally scarfed to agree with corner radii. Provide the following sizes:

Outside Dimensions (in.)	**Corner Radii** (in.)	**Thickness** (in.)	**Weight** (lb/ft)
1 3/4 by 1 3/4	5/32	0.08	1.7
2 by 2	5/32	0.08	2.0

Provide 7/16-inch diameter holes on the centerline of all 4 sides, space on one-inch centers along the entire post length beginning 1 inch from the top. Ensure holes are in true alignment and opposite each other directly and diagonally.

Ensure consecutive sizes of square tubes will freely telescope for 10 feet or more of their length without the necessity of matching any particular face to any other face.

832.02.02 Finish. Conform to ASTM A 653, G90, Structural Quality, Grade 340, Class 1. Galvanize both the interior and the exterior of the post. Coat the corner weld with zinc after the scarfing operation. Coat the steel with a chromate conversion coating and a clear organic polymer topcoat.

832.02.03 Tolerances. The Department may reject material falling outside any of the following tolerances:

- **A) Outside Dimensions.** ± 0.008 inch. Measure at least 2 inches from the end of the tube.
- **B) Wall Thickness.** ± 0.008 inch.
- **C) Holes.** ± 0.016 inches in diameter.
- **D) Convexity and Concavity.** Ensure that no sides exceed ± 0.1 inch. Measure in the center of the flat side relative to the corner.
- **E) Square (1 3/4-inch posts).** Ensure sides are 90 degrees to each other within ± 0.01inch.
- **F) Square (2-inch posts).** Ensure sides are 90 degrees to each other within ± 0.012 inch.
- **G) Twist.** Ensure twist does not exceed 0.02 inch in any one-foot length.
- **H) Straight.** Ensure deviation does not exceed 0.02 inch in any one-foot length.
- **I) Corner Radii.** 5/32 ± 0.016 inch.

832.03 TYPE II. Use hot wrought steel conforming to the physical properties of ASTM A 499-89, Grade 60, and conforming to the chemical requirements of ASTM A 1 for rails of nominal weight between 28.4 and 38 pounds per foot.

The Contractor may request to furnish posts made of material not complying with the specified properties. If desired, submit the written request for approval and include a

description of the physical and chemical properties of the proposed material. Include with the request a certified test report of a dynamic test by an independent laboratory substantiating that the posts, when double mounted in an 8-foot span, conform to the break-away requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

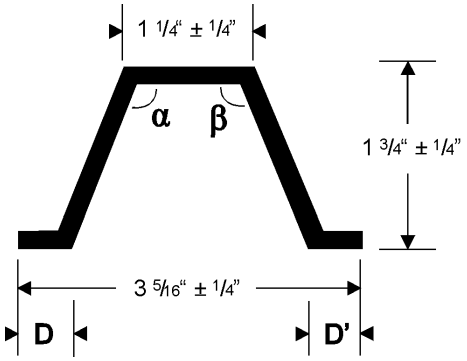
Provide a manufacturer's certification that the material was manufactured and tested according to the applicable specifications or approved alternate along with a report of the physical and chemical test results for each shipment.

832.03.01 Fabrication. Fabricate posts from uniform, modified, flanged channel sections.

Provide 3/8-inch diameter holes on the centerline, space on one-inch centers along the entire post length beginning one inch from the top. Align holes horizontally and vertically to accommodate back to back post installations.

Ensure that the area of contact between the posts and sign is symmetrical about the vertical axes of both sign and post and that the back side furnishes a solid bearing surface the entire length of the post for back to back installation.

Conform to the following typical section:



$\alpha = \beta \pm 4°$ $\quad$ D = D' ± 1/8 inch

832.03.02 Deflection. Test for deflection as simple beams, with the flanges in compression, on non-restricting supports 2 feet apart. Apply a load of 3,500 pounds at the center of the span at a deflection rate not to exceed 0.3 inch per minute. Transmit the load to the beam through a one-inch minimum diameter pin laid across the flanges. With the designated load applied, ensure that the deflection at the center does not exceed 0.18 inch. One minute after removal of the load, ensure that the deflection does not exceed 0.018 inch.

832.03.03 Finish. Galvanize according to AASHTO M 111 after fabrication.

832.04 PACKAGING. Securely fasten posts of the same type and length in bundles of 2,000 pounds or less in a manner that is easily handled by a fork lift and that prevents slipping during handling and shipping. The Engineer will reject posts whose finish is excessively damaged due to slipping, rubbing, or other reasons.

SECTION 833 — SIGN SUBSTRATES

833.01 ALUMINUM.

833.01.01 Panel Signs. Conform to ASTM B 221, Alloy 6063-T6. Fabricate signs from 12-inch wide extrusions and, if specified, compatible 6-inch wide extrusions. When a 6-inch extrusion is specified, use it as the bottom panel of the sign. Typical cross sections and minimum weights per foot are specified in the Plans. Use compatible side extrusions on all sign edges. Prepare surfaces of extrusions composing the sign face to receive retroreflective background material according to the extrusion and retroreflective material manufacturers' recommendations. Provide all remaining surfaces of extrusions and side extrusions with a soft matte finish.

833.01.02 Sheeting Signs. Conform to ASTM B 209, Alloy 6061-T6 or 5052-H38. Fabricate signs of the size and shape specified. Provide a thickness of 125 mils inch if any single edge dimension of the sign exceeds 3 feet. If no single edge dimension exceeds 3 feet, provide a thickness of 80 mils. Prepare the side of the sheet to be used as the sign face to receive retroreflective background material according to the sheeting and retroreflective material manufacturer's recommendations.

SECTION 834 — ROADWAY LIGHTING MATERIALS

834.01 WIRING. For all multiple circuit roadway lighting wires use single-conductor AWG copper of sizes specified in the Plans. Use No. 12 AWG copper wire as leads from pole bases or junction boxes to ballast terminals. Use stranded wire, except for ground wires. Ensure that all insulation for No. 8 or larger wire is Type USE (UL rated). Insulation for No. 10 or smaller wire shall be Type THW or THWN. Plainly mark all wire and cable according to the NEC. Use copper grounding conductors sized as specified by the NEC. Install copper service entrance conductors on the service poles sized and insulated as specified by the NEC.

834.02 DUCTED CABLE.

A) Cable. Use stranded annealed copper cable conforming to ASTM B 8 and ASTM B 33 for operation at 600 volts maximum. Use material that conforms to either the applicable requirements of ICEA Standard S-19-81, with thermoplastic insulation of GRS-rubber base conforming to Appendix K(A) of ICEA and listed by UL as Type USE for direct burial; or the application requirements of ICEA Standard S-66-524, with thermo-setting insulation of cross link polyethylene conforming to the requirement of Column "A" of ICEA and listed by UL as Type USE. Use cable that is preinstalled in the duct.

B) Duct. Use polyethylene duct with a minimum tensile strength of 3,100 psi for secondary cable underground. Provide for 40 percent maximum fill. Conform to ASTM D 3485.

834.03 CONDUIT. Except in load bearing areas, use UL rated, schedule 40, PVC conduit. In load bearing areas, use rigid steel conduit that is galvanized inside and out. For underground installation, use conduit of 1 1/4-inch or larger nominal diameter, except use 3/4-inch PVC conduit in the pole bases.

834.04 FUSED CABLE CONNECTOR KIT. Connect lighting fixtures to the feed circuits with fused cable connector kits. Place each kit in a transformer base, junction box, handhole, or other place as specified in the Contract. Ensure that the fused connector kit can be repeatedly disconnected without damage to the watertight seals and terminals or without reducing the conductivity below specifications. Provide a fused connector kit designed to break away without damage.

Use a fused connector kit that completely encloses and protects the fuse against damage from water and weather. Use a spring loaded contact between the fuse and fuseholder. Ensure that the springs are not a part of the current carrying circuit. Ensure that line and load side terminals of the fused connector kit positively connect to the conductors. Insulate and waterproof the terminals according to the manufacturer's recommendation. Construct the load side housing to retain the fuse when disconnected, and permanently mark it "LOAD" or "LOAD SIDE".

Use high interrupting capacity type fuses with a rating of 6 amperes. Use 13/32 by 1 1/2-inch fuses that are rated for 600 volts. Use fuses that protect circuits having a fault current capacity of up to 100,000 amperes AC. Use fuses tested to carry 110 percent of their rated capacity and that open at 135 percent in one hour or less.

834.05 LIGHTING STANDARDS. For the design of and materials for all lighting standards, conform to the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals, except as follows. For breakaway signs, and luminaire supports, conform to the breakaway requirements in the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals, 1985 edition as amended by the "1988 Interim Revisions", with the modification that the maximum allowable change in velocity is 16 feet per second. Provide lighting standards that consist of a tapered pole having a base affixed to the lower end, a bracket arm (if required), and a transformer base.

Furnish an opening near the top of the pole to provide for a cable entrance from the pole to the bracket arm to provide a smooth cable guide for wiring. Equip the top of the pole with a removable cap. Secure a one-piece anchor base to the lower end of the pole. Provide this base with 4 slotted holes to receive the anchor bolts and 4 tapped holes for securing the bolt covers. Provide 4 removable bolt covers with each base.

Use single member bracket arms for 4 and 6-foot mast arm assemblies. Use single or double member bracket arms for 8-foot mast arm assemblies. Use double pipe assemblies for 10, 12, and 15-foot mast arm assemblies. Double pipe assemblies consist of upper and lower members securely joined by means of vertical struts. Provide the pole end of the bracket arm with a cast or plate footing or clamp for positioning the assembly on the pole.

Galvanize the steel structures after fabrication.

Ensure that the pole manufacturer provides permanent marking on the pole base or other suitable location, giving the pole design number and other identification data so the poles may be compared with material brochures or drawings.

Provide each pole with a suitable handhole to allow access to the pole for maintenance of wiring inside the pole.

834.06 ANCHOR BOLTS. Fabricate anchor bolts from steel having a minimum yield strength of 50,000 psi. Provide L-shaped anchor bolts with a minimum length of one meter, a minimum diameter of one inch, and the horizontal leg at least 4 inches long. The manufacturer shall specify the correct dimensions; but in no case shall they be less than the dimensions specified above. Provide at least 6 inches of threads and 8 inches of galvanizing at the top of the vertical leg. Provide each anchor bolt with 2 galvanized hex nuts. Submit mill test reports on anchor bolts. Protect anchor bolt threads from damage during shipping.

834.07 TRANSFORMER BASES. Conform to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Ensure that each base has the following minimum outside dimensions: 17 inches high, 15 by 15-inch square bottom and 12 by 12-inch square top. Ensure that bases have a trapezoidal door with the following minimum dimensions: 11 inches high, 9 inches across the bottom, and 7.5 inches across the top. Construct the door of a high density polyethylene material in a color that matches the base. Provide each base with 4 loose bearing plates (anchor washers) and nuts to fasten the base to the anchor bolts. Fasten each transformer base to the base flange of the pole with 4 loose galvanized bearing plates and 4 galvanized steel connecting bolts and nuts. Use connecting bolts of the same diameter and strength as the anchor bolts. Submit mill test reports on the connecting bolts. The manufacturer shall specify the bolt circle and physical dimensions of the base bottom to ensure a proper foundation fit. Provide each transformer base with a 1/2-inch 13 UNC tapped hole or other suitable provisions for grounding purposes.

834.08 MARKERS FOR BURIED CONDUIT. Use 36 by 4 by 4-inch concrete posts reinforced with 4 No. 3 deformed steel bars. The Department will allow the use of standard rural right-of-way markers in lieu of conduit markers.

834.09 CONCRETE. Conform to Subsection 601.02 and 601.03. Use Class A concrete.

834.10 PAINTS. Use commercially available rust inhibiting primer for the prime coat. Use aluminum paint conforming to AASHTO M 69, or equal, for the intermediate and finish coats.

834.11 BALLASTS. Provide only high-pressure sodium luminaire ballasts that operate in a single circuit of the specified voltage ± 10 percent.

834.12 LUMINAIRES. Provide IES distribution as specified in the Contract; 2-inch slip-fitter mounting; and constant wattage type transformers.

Type A - 100 watt high-pressure sodium horizontal roadway luminaires
Type B - 150 watt high-pressure sodium horizontal roadway luminaires
Type C - 250 watt high-pressure sodium horizontal roadway luminaires
Type D - 400 watt high-pressure sodium horizontal roadway luminaires

Use luminaires that provide light levels conforming to AASHTO's An Informational Guide for Roadway Lighting. When submitting brochures for suggested luminaires, include iso lux curves, IES type distribution, lamp lumens, and typical ballast factor used for each type of luminaire. Submit the photometric data in IES format on an IBM compatible 3 1/2-inch floppy disk to the Central Office, Division of Traffic. Include with the submittal a point of contact and phone number to answer technical questions about the luminaire.

834.13 LAMPS. Provide only high-pressure sodium lamps with the following minimum initial light output:

Type A - 9 500 lm
Type B - 16 000 lm
Type C - 25 000 lm
Type D - 50 000 lm

834.14 MAGNETIC CONTACTORS AND CONTROL TRANSFORMERS. Provide only magnetic contactors that are 2 pole, sized as specified in the Contract, and have a 120 volt coil. Protect each contactor coil by a 15 amp fuse. Equip contactors with control switches for both automatic and manual actuation. Provide photoelectric switches for automatic actuation. Use photoelectric controls that are solid state cadmium sulfide type designed for use in 120 volts 60 Hz circuits and rated for 1,000 watts resistive load. Use photoelectric controls with built-in surge protection and designed to provide an output circuit closure when photoelectric control components fail. Provide photoelectric controls and mounting bases that are twist-lock type. Provide 2 pole, double throw switches that manually actuate. Ensure that each switch has minimum rating of 125 volts, 15 amperes.

Use control transformers that are 1 KVA, single phase, 240/480 volt primary, 120/240 volt secondary, dry type, 60 Hz, with primary winding isolated from secondary winding. Use transformers that are capable of indoor or outdoor installation and have a maximum temperature rise of 99 °F at 104 °F ambient temperature.

834.15 DISTRIBUTION TRANSFORMERS. Equip all distribution transformers with 2, 2.5 percent taps above and below rated primary voltage. Provide transformers that are protected by a primary lightning arrester with an indicating fuse cutout of the voltage and amperage as specified in the Plans.

834.16 SECONDARY LIGHTNING ARRESTERS. Provide only secondary lightning arresters designed for use with the specified voltage and rated at 0-650 volts RMS.

834.17 WEATHERPROOF ENCLOSURES. Fabricate enclosures from 125-mil or thicker natural finished aluminum. Provide enclosures with a No. 2 Corbin lock and keys. Install a 120 VAC GFI duplex receptacle in the enclosure with a separate 20 amp breaker.

834.18 GROUND RODS. Provide only composite shaft ground rods consisting of a pure copper exterior that has been inseparably molten welded to a steel core. Use rods with a minimum diameter of 1/2 inch and a minimum length of 8 feet. Equip the rods with copper or bronze clamps.

834.19 WOOD POLES. Use Class 4 poles, of the length specified in the Contract, conforming to Subsection 820.

SECTION 835 — TRAFFIC CONTROL DEVICES

835.01 DESCRIPTION. This section defines minimum acceptable design and operational standards for traffic control devices used in the Commonwealth.

835.02 TIME CLOCKS. Use time clocks that are solid state, microprocessor based units with one to 4 relay outputs rated at 10 amps, 115 VAC resistive load. Connect all relay contacts and clock power through a 16 pin circular plastic connector (Amp #520258-3 or approved equal). Pin designations are as follows:

Pin No.	Function	Pin No.	Function
1	Line	9	#4 Com
2	Neutral	10	#1 N.O.
3	Ground	11	#3 Com
4	#1 Com	12	#3 N.C
5	#1 N.C	13	#3 N.O.
6	#2 Com	14	#4 N.C.
7	#2 N.O.	15	#4 N.O.
8	No Con.	16	#2 N.C.

Operate clocks with a supply voltage from 95 to 135 VAC, 60 Hz at temperatures from -29 to + 165 °F.

Supply backup power for the clock with a battery or capacitor. Ensure that backup power maintains time keeping and program steps for at least 48 hours.

Enter all programming through the keyboard. Ensure that programming features include at least 32 program steps. Ensure that each step shall program a single relay output by hour and minute and allow a single day of week, Monday through Friday or Saturday and Sunday to be set. Provide clocks that have automatic daylight savings time adjustment as default with a daylight savings time override option controlled from the keyboard. Provide clocks that have manual override capability for each relay. Provide clocks that have a self test function which exercises relay outputs. Ensure that units are enclosed in a durable case that can mount on a vertical surface. Supply each unit with a female mating harness with 3-foot wires. Wire the harnesses for the number of relays used in the clock. Label each wire one foot from the plug with permanent non-fading wire labels indicating the wire function.

835.03 PEDESTRIAN PUSHBUTTON DETECTORS. Provide a pedestrian detector that consists of a single plunger push button control switch with a 2 1/4-inch (minimum) chrome plated mushroom shaped plunger. Provide a 5-A (minimum), 110 VAC switch with 2 circuit (NO/NO) slow make contacts. Ensure that pushing of the button closes both NO circuits. Use a switch body that is die cast and painted with a black wrinkle finish paint. Include a neoprene gasket for sealing the switch body to the enclosure.

835.04 EQUIPMENT TESTING. The Department requires that each purchased individual cabinet, controller, conflict monitor, modem, and loop amplifier is environmentally tested. At a minimum, test each unit purchased according to "Traffic Signal Control Equipment Specifications" by the California Department of Transportation. The manufacturer is free to suggest additional tests or variations in the above procedures that may be part of an existing quality control program.

A representative of the Department may travel to the testing site to verify that the environmental testing is being carried out properly and to observe manufacturing practices used at the factory. The manufacturer shall submit a proposed testing procedure and schedule 30 calendar days in advance for evaluation by the Department. Ensure that the

test procedures, environmental chambers, automatic test equipment, display boards, power supplies, and controls are described in detail. Resolve any problems in the testing procedure before the representative arrives.

Test cabinets at ambient room temperature. Use an automatic or semi-automatic method for checking cabinet wiring between equipment harnesses.

835.05 SIGNALS AND BEACONS.

835.05.01 Fittings and Mounting. Supply all traffic control signals, beacons, and lane control signals, unless otherwise specified, with necessary fitting including wire entrance fittings and swivel type balance adjuster for span wire mounting. Design wire entrance fitting to prevent entrance of water when using normal drip loops. Galvanize or cadmium plate span wire clamps and bolts.

Ensure that the total loose play rotational tolerance between span wire clamp and wire entrance fitting, with swivel adjuster assembled, is not more than 3 degrees.

Use mounting arms and brackets made of 1 1/2-inch standard metal IPS pipe. The Department will allow cast or fabricated bottom brackets.

Ensure that signals are adjustable, and arrange them so that each face may be rotated to and positively locked within not more than 5 degrees of any position in the horizontal plane. Use a separate locking ring mating with serrations cast or molded into the signal housing. Do not use serrations cast into the wire outlet body. Use a locking ring designed with a minimum of 2 pins or tabs to mate with corresponding holes or notches in the wire outlet body. Use locking rings that are machined to provide sharp, well formed serrations that exactly match the serrations in the signal housing.

835.05.02 Housings. Provide metal housings cast from a non-ferrous, non-corrosive aluminum alloy. Use parts that are fitted with rubber or neoprene type gaskets to provide weather tight seals. Use housing sections of the same type and make of manufacturer that are interchangeable. Reinforce tops and bottoms to which supporting attachments are fastened to prevent breakage from vibration and shock.

Use polycarbonate signals that are the same in appearance as cast aluminum signals, except mold the housings, doors, and visors from polycarbonate resin to withstand a 70 foot-pound impact without fractures or permanent deformation. Ensure that the color is homogeneous throughout.

Use doors of the same material as the housing. Ensure that doors are suitably hinged and held securely to the housing by simple locking devices, which do not require tools of any kind for opening. Use stainless steel hinge pins, lens clips, etc.

835.05.03 Optical Units. Each optical unit is a complete assembly of lamp receptacle, reflector, cover glass or lens, and door with all necessary supporting parts and with a single signal indication. Conform in all respects, except as further restricted by this section, to the standards of the Institute of Traffic Engineers (ITE).

Provide incandescent illuminated optical units that contain a heat resistant lamp receptacle positioned to provide a light center at the focal point of the reflector. Use reflectors that are “ALZAK” process coated aluminum or other approved equal. Use a 650-watt standard traffic signal lamp in an 8-inch traffic signal, 9-inch pedestrian signal, or 12-inch one-section pedestrian signal. Use a 1 950-lumen standard traffic signal lamp in a 12-inch traffic signal, lane control signal, or 12-inch pedestrian signal.

Construct and mount optical units to provide easy access for all maintenance and repairs including wiring within the signal housing. Design optical units so that the use of tools of any kind are not required for replacing signal lamps.

Wire and connect each lamp receptacle to a suitable terminal block within the signal housing with minimum No. 18 AWG, 194 °F, 600 volt, color-coded, stranded fixture wire. Do not use braided wire. Locate the terminal block in the second section from the top in multi-section faces.

Use glass lenses. Ensure that lenses of the same nominal diameter are interchangeable regardless of manufacturer.

Each signal face contains one or more complete optical units in suitable housings for control in one direction only and is designated as one-section, 2-section, 3-section, etc.

835.05.04 Signal Heads. Each signal head contains one or more signal faces and is designated as one-way, 2-way, 3-way, etc.

One-section signals are standard flashing beacons. For one-way and two-way flashing beacons, supply signal heads with amber or red lenses as specified in the Contract. Mount signals with 2 or more sections vertically with indications positioned according to the MUTCD.

Fit each optical unit with a visor or hood. Provide combination or tunnel type visors that enclose at least 80 percent of the lens circumference for amber lenses. Supply standard visors that enclose at least 50 percent of the lens circumference for all red or green lenses. Supply visor lengths that are approximately the same as the lens diameter and designed to minimize sun phantom. Attach hoods with screws. Do not use snap in hoods.

Ensure that 8-inch signals display circular indications of not less than 7 3/4 inches in diameter. Ensure that 12-inch signals display circular indications of not less than 11 1/2 inches in diameter.

Ensure that signal sections of both 12-inch and 8-inch signals of the same make or manufacture are interchangeable to provide for optional combinations of lens sizes. Use tops and bottoms of signals that have circular openings for 1 1/2-inch IPS rigid pipe, and use replaceable tops and bottoms that are interchangeable. Close all unused openings with removable plugs and caps.

Use signal heads that are assembled and wired. Supply visors, brackets, backplates, hangers, etc. that are packaged and shipped within the same carton as the signal head for which they are being supplied, with or without them attached to the signal.

835.05.05 Pedestrian Signals. Use pedestrian signals that consist of a one-piece die cast aluminum housing. Use a housing that has 1 1/2-inch holes in top and bottom for post top or bracket mounting. These indications consist of the illuminated symbols of a walking person (symbolizing WALK) and an upraised hand (symbolizing DON'T WALK).

Use signal heads that are assembled and wired. Supply brackets, arms, wire entrance fittings, and all other necessary hardware that are packaged and shipped within the same carton as the signal head for which they are being supplied with and without them attached to the signal.

835.05.06 Painting. Paint all signals and beacons (except black polycarbonate), arms and braces, brackets, trunions, wire entrance fittings, sign housings, etc. black with 2 coats of high grade exterior gloss enamel. Paint the inside of all hoods and visors dull black to minimize glare reflections.

Prepare, degrease, and prime all painted surfaces before painting to prevent chipping and peeling.

Ensure that all miscellaneous hardware is corrosion resistant, or galvanize or plate it after any drilling, threading, or welding.

835.06 TRAFFIC LOOP ENCAPSULANT. Provide compressive yield strength adequate to withstand heavy vehicular traffic as well as flexibility to withstand normal movement in asphalt and concrete pavements. Upon testing, if any physical property, although not specifically described herein, renders the product unsuitable, the Engineer may reject the product.

Use an encapsulant that is a one-part polyurethane material of a composition that, within its stated shelf life, cures only in the presence of moisture. Use a sealant suitable for use in both asphalt and concrete. Use a non-shrinking and non-stringing encapsulant that provides a void-free encapsulation for detector loop wires.

Ensure that the cured encapsulant has the following properties:

Hardness (Indentation)	25 - 40	(Shore A)

Minimum Tensile Strength	150 psi	ASTM D 412
Minimum Elongation	125%	ASTM D 412 2-inch/minute pull

Ensure that the cured sealant has the following chemical reactions:
(7-day cure at room temperature, 24-hour immersion)

Deicing Chemical	No Effect
Gasoline	Slight Swell
Hydraulic Brake Fluid	No Effect
Motor Oil	No Effect
Calcium Chloride (5%)	No Effect

Ensure that the wet sealant has the following properties:

Weight	10 ± 1.0 pounds per gallon
Viscosity	20,000-50,000 CPS
Drying Time	Touch - 24 hours Complete - 30 hours

Use one-quart tubes of loop sealant that are suitable for use with a standard caulking gun. Provide each tube with a plastic nozzle to facilitate placing of the material in the pavement slot.

835.07 WARRANTIES. Warranty equipment for a period of 6 months, or provide the manufacturer's standard warranty, whichever is greater.

835.08 DOCUMENTATION. With each unit purchased under this section include one documentation package consisting of:

1) A complete instruction manual.
2) A complete step by step explanation of circuit theory and operation.
3) A complete schematic.
4) A complete parts layout. Parts identification may be silk-screened directly on circuit board.
5) All point to point voltages and wave forms pertinent to proper servicing. This information may be included on the schematic diagram.
6) Complete installation procedures for the unit.
7) A complete parts list with full information as to availability of any custom or nonstandard parts.
8) All applicable warranties and guarantees.

SECTION 836 — DURABLE PREFORMED PAVEMENT MARKINGS TYPE I TAPE

836.01 TYPE I TAPE. Use preformed pavement marking material consisting of white or yellow films with glass beads incorporated to provide immediate and continuing retroreflection.

Use preformed pavement marking material capable of adhering to new dense and open graded asphalt surfaces, during the paving operation, or portland cement concrete by a pre-coated pressure sensitive adhesive. The Engineer may require a primer to precondition the pavement surface. Ensure that the markings conform to pavement contours by the action of traffic. Ensure that, after application, the markings are immediately ready for traffic.

Ensure that these markings provide long term reflectivity, as determined in the following performance requirements, when applied according to the manufacturer's instructions.

Ensure that the preformed markings are suitable for use one year after the date of receipt when stored according to the manufacturer's recommendations.

A) Composition. Use retroreflective preformed pavement markings consisting of a mixture of high quality polymeric materials, pigments, and glass beads distributed throughout its base cross sectional area.

B) Reflectance. Ensure that the white and yellow markings have the following initial minimum reflectance values as measured according to the testing procedures of ASTM D 4061. Measure the specific luminance (SL), and express it as millicandelas per lux per square meter. Use a test distance of 30 meters and a sample size of a 24 by 30-inch rectangle.

INITIAL REFLECTANCE			
Color	Entrance Angle	Observation Angle	Specific Luminance
White	86.5º	1.0º	700 minimum
White	86.0º	0.2º	1,100 minimum
Yellow	86.5º	1.0º	500 minimum
Yellow	86.0º	0.2º	800 minimum

C) Skid Resistance. Ensure that the surface of the retroreflective material provides an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303.

D) Patchability. Ensure that the pavement marking material is capable of use for patching worn areas of the same type according to the manufacturer's recommendations.

E) Material Warranty. For a period of 48 months from the date of installation, regardless of ADT and under normal traffic conditions, the manufacturer will provide replacement material for any material used as longitudinal markings that (1) fails to retain the minimum reflectivity values (minimum replacement zone is 300 feet of roadway length), or (2) fails due to loss of adhesion or complete wear through.

The Department will take measurements according to KM 201. The minimum reflectivity requirements, as measured with a LTL2000 retroreflectometer or mobile 30M geometry device, are as follows:

White: 200 mcd/lux/square meter
Yellow: 150 mcd/lux/square meter

F) Testing and Acceptance. Furnish the manufacturer's typical test analysis for the durable preformed pavement markings and the manufacturer's certification stating that the material conforms to this section.

The Engineer will submit the above documentation, accompanied by a Sample Identification Form to the District Materials Engineer. The Department will base acceptance on a review of the test data, a certification statement, and initial field evaluation.

SECTION 837 — EXTRUDED THERMOPLASTIC PAVEMENT MARKING MATERIALS

837.01 PRE-MIX BEADS. Use uncoated Type 1 beads conforming to AASHTO M 247.

837.02 DROP ON BEADS. Conform to Section 839. If any shipment consists of 10,000 pounds or less, randomly select 2 one quart samples to represent the shipment. Ensure that a signed statement of certification accompanies each sample and includes the following information:

1) A statement that the beads conform to Section 839.
2) The quantity of beads represented in the lot or batch.
3) The destination of the shipment.

837.03 THERMOPLASTIC MATERIAL. Use a maleic-modified glycerol ester resin (alkyd binder) to formulate the thermoplastic material. Use material that, when heated, does not exude fumes that are toxic or injurious to persons or property.

837.03.01 Composition. Ensure that the pigment, beads, and filler are uniformly dispersed in the resin. Use material that is free from all skins, dirt, and foreign objects, and conforms to following table.

COMPOSITION (Percentage by Weight)		
Component	White	Yellow
Binder, [(1)]	18.0 min.	18.0 min.
Glass Beads (Premixed)	30 - 40	30 - 40
Titanium Dioxide	10.0 min.	—
Calcium Carbonate & Inert Fillers [(2)]	42.0 max.	50.0 max.
Lead Chromate	0.0 max.	4.0 min.

[(1)] *Use a binder that consists of a mixture of synthetic resins, at least one being solid at room temperature, and high boiling point plasticizers. Ensure that at least one-third of the binder composition is solid maleic-modified glycerol ester resin and is not less than 8 percent by weight of the entire material formulation. Do not use alkyd binder that contains petroleum based hydrocarbon resins.*

[(2)] *The manufacturer may choose the amount of calcium carbonate and inert fillers, providing all other requirements of this section are met.*

837.03.02 Physical Characteristics.

A) Specific Gravity. Do not exceed 2.3.

B) Color. For thermoplastic material heated for 4 hours at 425 °F under agitation, conform to the following luminosity and color requirements:

1) Luminosity. - Daylight reflectance at 45 degrees entrance angle, 0 degrees observation angle.

White - 75 percent minimum.
Yellow - 45 percent minimum.

2) Color - Conform to the FHWA color standard 595B-38907 for yellow and 595B-37925 for white.

C) Set Time. Use material that, when applied at a temperature range of 415 ± 15 ºF and thickness of 40 to 120 mils, sets to bear traffic in not more than 2 minutes when the air and road surface temperature is approximately ≥ 50 ± 3 ºF, and not more than 10 minutes when the air and road surface temperature is approximately < 50 ± 3 ºF.

D) Bond Strength. After heating the thermoplastic material for 4 hours at 425 ºF, ensure that the bond strength to concrete exceeds 180 psi, according to ASTM D 4796.

E) Cracking Resistance at Low Temperature. After heating the thermoplastic material for 4 hours at 425 ºF, applying it to concrete blocks, and cooling it 46 ºF, ensure that the material shows no cracks when observed from a distance exceeding one foot.

F) Impact Resistance. After heating the thermoplastic material for 4 hours at 425 ºF and forming test specimens, ensure that the impact resistance is a minimum of 1.13 joules.

G) Softening Point. After heating the thermoplastic material for 4 hours at 425 ºF and testing according to ASTM D 36, ensure that the materials have a softening point of 215 ± 15 ºF.

H) Flowability. After heating the thermoplastic material for 4 hours at 425 ºF and testing for flowability, ensure that the white thermoplastic has a maximum residue of 18 percent and the yellow thermoplastic has a maximum residue of 21 percent.

I) Yellowness Index. Use white thermoplastic material that does not exceed a yellowness index of 0.15.

J) Flowability (Extended Heating). After heating and stirring the thermoplastic material for 8.5 hours at 425 °F and testing for flowability, ensure that the thermoplastic has a maximum residue of 28 percent.

K) Flash Point. Use thermoplastic material that has a flash point not less than 475 °F when tested according to ASTM D 92.

L) Storage Life. Ensure that the material conforms to this section for a period of one year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this one year period. The manufacturer shall replace any material not conforming to the above requirements.

837.03.03 Certification, Testing and Approval.

A) Sampling. The manufacturer shall perform tests on a minimum of one composite sample per lot of thermoplastic produced. Provide a composite sample composed of equal portions of randomly selected samples taken from each 10,000 pounds during the lot's production. Use a lot size of approximately 44,000 pounds unless the total order is less than this amount. Ensure that the one quart composite sample is collected by an independent laboratory approved by the Division of Materials.

B) Testing. The manufacturer shall perform the following tests on the thermoplastic pavement marking material: Color, Reflectance and Yellowness Index, Bond Strength (Yellow and White), Low Temperature Stress Resistance, Impact Resistance, Softening Point, Flowability, Flowability (Extended Heating), Drying Time and Specific Gravity.

C) Submission. Before shipment of the thermoplastic material, the manufacturer shall submit to the Division of Materials a 1/2-gallon composite sample of the thermoplastic material, a copy of the manufacturer's test results, a listing of the theoretical composition of the thermoplastic material (see Composition table in Subsection 837.03.01) and a signed statement of certification that includes the following information:

1) A statement that the thermoplastic material complies with all requirements of this section.

2) The quantity of material represented in the lot or batch.
3) The destination of the shipment.

D) Verification. The Department reserves the right to verify the manufacturer's test results by conducting any or all of the tests listed above. The Division of Materials or an approved independent laboratory will perform this testing at the Department's expense and according to AASHTO T 250 and Kentucky Standard Test Methods. Upon completion of testing, the Division of Materials will notify the supplier of approval and forward copies of the material's certification and approval to the Division of Traffic.

837.03.04 Packaging. Package thermoplastic pavement marking material in suitable 50-pound containers to which it shall not adhere during shipment or storage. Include a label stating that the material is to be maintained within a temperature range of 400-440 ºF during application. Provide the thermoplastic material in either block or granular form.

SECTION 838 — FLEXIBLE DELINEATOR POSTS

838.01 GENERAL. Furnish surface and ground mounted flexible delineator posts from the Department's List of Approved Materials. The Department will approve flexible delineators based upon their NTPEP performance evaluation. The Department considers the flexible delineator posts to include the post, reflective element, and mounting hardware.

838.02 PACKAGING. Securely fasten posts of the same type and length in bundles of 2,000 pounds or less in a manner that is easily handled by a fork lift and that prevents slipping during handling and shipping. The Engineer will reject posts with excessively damaged finishes.

SECTION 839 — KY TYPE I GLASS BEADS

839.01 GLASS BEADS. Use for application to reflective pavement markings. Conform to AASHTO M 247, moisture resistant specifications with the following additional requirements for gradation and percentage of rounds:

Gradation:	Sieve Size	Percent Passing
	No. 20	98-100
	No. 30	70-90
	No. 40	—
	No. 50	0-20
	No. 80	0-5

Rounds: 70% minimum for + 50 beads

839.01.01 Sampling. The Department will obtain random samples of all shipments that are intended for use by State Traffic Forces at the point of delivery. The Department will evaluate the beads for acceptance prior to use. The Department will accept beads for Contractor use based upon manufacturer certification.

839.01.02 Testing. The Department will test according to AASHTO M 247 and the following.

A) Chemical Resistance Test. Place three, 0.1 to 0.2-ounce, samples of the beads in separate Pyrex-glass beakers or porcelain dishes. Cover one sample with distilled water; one with a 3N solution of sulfuric acid; and one with a 50 percent solution of sodium sulfide. Examine the samples microscopically after one hour of immersion. Reject the beads if they darken or "frost".

B) Moisture Resistance Test. Place approximately 2 pounds of glass beads in a clean cotton bag not treated with sizing material. Immerse the bag in water, completely covering the beads, for approximately 30 seconds. Remove the bag and wring free of excess water. Hang the bag in room air for 2 hours to dry. Transfer the beads slowly to a clean, dry, standard (4-inch stem, and a 1/4-inch diameter exit) glass funnel. Accept beads that flow freely through the funnel.

839.01.03 Approval. The Department will notify the vendor of acceptance when all testing is complete. The Department will evaluate beads used by the Contractor as part of the painted line by use of hand-held or mobile retroreflectance readings.

SECTION 840 — RAISED MARKERS

840.01 TYPE IV MARKERS. Provide markers from the Department's List of approved Materials. Ensure that the markers conform to the following:

A) Prismatic Reflectors. Use reflectors that are viewable from a single or opposite direction.

B) Shell. Fabricate the acrylic plastic shell with methyl methacrylate conforming to Federal Specification L-P-380C, Type I, Class 3. Fill the shell with a tightly adherent potting compound.

C) Lens. Fabricate the lens with a layer of tough untempered glass.

840.01.01 Dimensions. Provide markers that are each 4 ± 1/2 inches by 2 ± 1/4 inches at the base. Ensure that the height of the marker is at least 0.40-inches and no higher than 1/2 inch after preparation of the base of the marker for bonding.

840.01.02 Outer Surface. Provide a smooth outer surface of the shell except for purposes of identification.

840.01.03 Base Surface. Ensure that the base of the marker is substantially free from gloss or substances that may reduce its bond to adhesive. Laminate an elastomeric pad to the base of each marker prior to attaching to Type V casting with adhesive.

840.01.04 Strength Test. Markers shall support a load of 4,000 pounds at room temperature when applied in the following manner:

Position a marker base down in the center of a fixture consisting of a 1/2-inch thick flat steel plate. Apply a load to the top center of the marker by means of a one-inch diameter by one-inch high solid steel plug at a rate of 0.03 inches per minute. Failure is when either breakage or significant deformation of the marker occurs at any load less than 4,000 pounds.

840.01.05 Impact Test and Temperature Cycling. Perform each impact test on a sample sufficient to provide 20 lenses from the same lot for testing. Condition the markers in a convection oven at 130 °F for one hour.

While at the elevated temperature, impact the reflective face with a 1/2-pound dart fitted with a 1/4-inch radius spherical head dropped 18 inches perpendicularly onto the center of the reflective surface. Cracks in the impact area shall be generally concentric in appearance. There shall be no more than 2 radial cracks longer than 1/4 inches. There shall be no radial cracks extending to the edge of the glass.

Subject samples to 3 cycles of 140 °F for 4 hours followed by -4 °F for 4 hours. There shall be no cracking or delamination following temperature cycling.

In either the impact or temperature cycling test, if 90 percent of the test samples conform to the above requirements, the Engineer will accept the lot. If 20 percent of the sample fails, the Engineer will reject the lot. If 15 percent of the sample fails, the Engineer will request a resample. If more than 10 percent of the resample fails, the Engineer will reject the lot.

840.01.06 Reflectivity. Provide the following specific reflectivity of the reflective surface at 0.2 degrees divergence angle, as tested according to KM 64-203, when the incident light is parallel to the base of the marker:

MINIMUM SPECIFIC REFLECTIVITY candelas/lux/unit marker		
Color	Incidence Angle	
	0°	20°
Silver-White	2.7	0.9
Amber	1.8	0.6
Red	0.5	0.22

840.02 TYPE V MARKERS. Type V markers consist of an iron casting with a Type IV marker (mono or bi-directional) attached. Shape both ends to deflect a snowplow blade. Design the casting to allow the Type IV marker to be removed and replaced. The Department will approve the design of Type V markers before use. The Department will approve markers that incorporate the typical features specified in this section and the Standard Drawing and have shown acceptable performance in actual service on a roadway pavement. The Department will reject, at any time, markers that deviate from previously approved designs.

840.02.01 Dimensions. Conform to the Standard Drawing. Ensure that the installed height is approximately 0.4 inches above the road surface.

840.02.02 Casting Material. Use nodular iron conforming to ASTM A 536, Grade 72-45-05, hardened to 52-54 RC.

840.02.03 Surface. Ensure the surface of the keel and web is free of scale, dirt, rust, oil, grease, or any other contaminant that may reduce its bond to the epoxy adhesive.

840.02.04 Weight. Approximately 4.6 pounds.

840.02.05 Identification. Mark each casting with the manufacturer's name and model number of marker.

840.03 TYPE IVA MARKERS. Conform to the requirements for Type IV markers excepting dimensions. Provide markers that are each 4.7 ± 0.25 by 2.3 ± 0.25 inches at the base. Ensure that the height of the marker is at least 0.40 inches and no higher than 0.50 inches.

840.04 SAMPLING. For the purpose of sampling, a shipment consists of the amount of material received in one delivery even though it may represent only partial delivery of the Contract quantities. Obtain samples from at least 5 widely separated and randomly chosen packages of like materials included in the shipment.

Check the markers for dimensional requirements detailed in this section. Obtain a manufacturer's certification for each shipment.

Include with each shipment of adhesive a written statement from the manufacturer certifying that the material furnished conforms to the recommendations of the marker manufacturer, and stating the minimum temperature the adhesive can be satisfactorily mixed and applied.

840.05 PACKAGING. Suitably and substantially package all materials with the name and address of the manufacturer or vendor, Contract or Purchase Order number, kind of material, trade name, and net contents plainly marked on each package.

SECTION 841 —LATEX ADMIXTURE

841.01 DESCRIPTION. This section covers latex admixtures for concrete bridge deck overlays.

841.02 REQUIREMENTS. Select a latex admixture from the Department's List of Approved Materials. Use a latex admixture that is produced in the United States.

Manufacturers desiring prequalification of new products shall have their product tested and evaluated by a qualified independent laboratory, or the Department's Division of Materials, according to the Prequalification Test Program in the U.S. Department of Transportation Research Report No. FHWA-RD-78-35. When analysis is performed by an independent laboratory, the manufacturer shall submit the certified test results along with a 5-gallon sample of the latex admixture to the Department's Division of Materials. The Department will approve the latex admixture based upon the submitted information and evaluation of the sample.

Use only latex admixtures that are free of chlorides.

Include with each shipment of latex admixture a report of tests performed according to the Certification Program in Report No. FHWA-RD-78-35. In addition to actual test results, include in the report the date of manufacture, batch or lot number(s), quantity represented, manufacturer's name, place of manufacture, a statement that all test results are satisfactory, the date the one-year certification period will expire, and signature of manufacturer's representative.

The Department will check sample and test each lot of latex and will remove it from the list of approved materials at any time there is an indication of nonconformity or questionable quality.

Package and store the latex admixture in containers and storage facilities that protect the material from freezing and from temperatures above 85 °F. When storing outside of buildings during moderate temperatures, keep the material shaded and away from direct sunlight. Do not use any latex admixture exposed to freezing temperatures without approval from the Division of Materials.

SECTION 842 — PAVEMENT STRIPING PAINT

842.01 DESCRIPTION. This section covers quick-drying pavement striping paint for permanent applications.

842.02 APPROVAL. Select materials that conform to the composition requirements below. Submit initial samples for approval before beginning striping operations. The initial sample may be sent from the manufacturer of the paint. The Department will randomly sample and evaluate the paint each week that the striping operations are in progress.

PAINT COMPOSITION		
Property and Test Method	Yellow	White
Color Spectrophotometer using a D65 illuminant at 45° illumination and 0° viewing with a 2° observer	Fed Std. 595B-38907 With a maximum variation of 2.0 ΔE_{cmc}	Fed. Std. 595B-37925 With a maximum variation of 2.0 ΔE_{cmc}
Lead ASTM D 3335	< 5ppm	<5ppm
TiO_2 ASTM D 4764	NA	10% by wt. of pigment min.
VOC ASTM D 2369 and D 4017	1.25-lb/gal max.	1.25-lb/gal max.
Contrast Ratio (at 10 mils wft.)	0.96	0.96

842.03 ACCEPTANCE PROCEDURES FOR NON-SPECIFICATION PAVEMENT STRIPING PAINT. When non-specification paint is inadvertently incorporated into the work the Department will accept the material with a reduction in pay. The percentage deduction is cumulative based on its compositional properties, but will not exceed 60 percent. The Department will calculate the payment reduction on the unit bid price for the routes where the non-specification paint was used.

PAVEMENT STRIPING PAINT REDUCTION SCHEDULE				
Non-conforming Property	Color	Lead	TiO_2	VOC
Reduction Rate	20%	60%	20%	60%

SECTION 843 — GEOTEXTILE FABRICS

843.01 DESCRIPTION. This section covers requirements for geotextile fabrics for slope protection and channel lining, underdrains, subgrade or embankment foundation stabilization, and drainage blankets.

843.01.01 Geotextile Fabric. Use either woven or non-woven fabric consisting only of long chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. Use fabric that is inert to commonly encountered chemicals and free of defects or flaws significantly affecting its physical or filtering properties.

Ensure that the fabric, except wrapping placed directly against perforated pipe, is formed in widths of at least 6 feet. When necessary, sew sheets of fabric together to form required fabric widths. Sew the sheets of fabric together at the point of manufacture or other approved locations.

The geotextile manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with this section.

A) Packaging. During all periods of shipment and storage, wrap the fabric in a heavy duty protective covering to protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140 °F, mud, dirt, dust, and debris.

B) Physical Requirements. Conform to the following applicable table as specified for each use.

C) Acceptance. Obtain the Department's approval for all material before incorporating it into the project.

TYPE I FABRIC
GEOTEXTILES FOR SLOPE PROTECTION AND CHANNEL LINING

Property	Minimum Value[1]	Test Method
Grab Strength (lbs)	200	ASTM D 4632
Elongation (%)	15	ASTM D 4632
Sewn Seam Strength[2] (lbs)	180	ASTM D 4632
Puncture Strength (lbs)	80	ASTM D 4833
Burst Strength (psi)	320	ASTM D 3786
Trapezoid Tear (lbs)	50	ASTM D 4533
Apparent Opening Size U.S. Std. Sieve	Sieve U.S. #40	ASTM D 4751
Permeability (cm/s)	0.004	ASTM D 4491
Ultraviolet Degradation at 500 hours	70% strength retained for all classes	ASTM D 4355
Flow Rate (gal./min./ft^2)	20	ASTM D 4491

TYPE II FABRIC GEOTEXTILES FOR UNDERDRAINS (except pavement edge drains)		
Property	Minimum Value[1]	Test Method
Grab Strength (lbs)	80	ASTM D 4632
Elongation (%)	N/A	ASTM D 4632
Sewn Seam Strength[2] (lbs)	70	ASTM D 4632
Puncture Strength (lbs)	25	ASTM D 4833
Burst Strength (psi)	130	ASTM D 3786
Trapezoid Tear (lbs)	25	ASTM D 4533
Apparent Opening Size U.S. Std. Sieve	Sieve U.S. #50	ASTM D 4751
Permeability (cm/s)	0.010	ASTM D 4491
Ultraviolet Degradation at 150 hours	70% strength retained for all classes	ASTM D 4355
Flow Rate (gal./min./ft^2)	50	ASTM D 4491

TYPE III FABRIC GEOTEXTILES FOR SUBGRADE OR EMBANKMENT STABILIZATION		
Property	Minimum Value[1]	Test Method
Grab Strength (lbs)	180	ASTM D 4632
Elongation (%)	N/A	ASTM D 4632
Sewn Seam Strength[2] (lbs)	160	ASTM D 4632
Puncture Strength (lbs)	67	ASTM D 4632
Burst Strength (psi)	290	ASTM D 3786
Trapezoid Tear (lbs)	67	ASTM D 4533
Apparent Opening Size U.S. Std. Sieve	U.S. #40	ASTM D 4751
Permeability (cm/s)	0.002	ASTM D 4491
Ultraviolet Degradation at 150 hours	70% strength retained for all classes	ASTM D 4355
Flow Rate (gal./min./ft^2)	7	ASTM D 4491

TYPE IV FABRIC GEOTEXTILES FOR EMBANKMENT DRAINAGE BLANKETS AND PAVEMENT EDGE DRAINS		
Property	Minimum Value[(1)]	Test Method
Grab Strength (lbs)	180	ASTM D 4632
Elongation (%)	N/A	ASTM D 4632
Sewn Seam Strength[(2)] (lbs)	160	ASTM D 4632
Puncture Strength (lbs)	80	ASTM D 4833
Burst Strength (psi)	290	ASTM D 3786
Trapezoid Tear (lbs)	50	ASTM D 4533
Apparent Opening Size U.S. Std. Sieve	U.S. #50	ASTM D 4751
Permeability (cm/s)	0.008	ASTM D 4491
Ultraviolet Degradation at 150 hours	70% strength retained for all classes	ASTM D 4355
Flow Rate (gal./min./ft^2)	40	ASTM D 4491

(1) Minimum. Use value in weaker principal direction. All numerical values represent minimum average roll value (i.e., test results from any sampled roll in a lot shall meet or exceed the minimum values in the table).

(2) Values apply to both field and manufactured seams.

843.01.02 Acceptance Procedures for Non-Specification Fabric. Ensure that all geotextile fabric conforms to the requirements of this section. However, when non-specification geotextile fabric is inadvertently incorporated into the work before completion of testing, the Department may accept the material with a reduction in pay, provided the failure is marginal and will not cause poor performance. When the failure is excessive, then remove the geotextile fabric, and replace it unless the Engineer determines that the geotextile fabric can remain in place. The Department will apply the largest payment reduction when the material fails to meet more than one specification requirement. The Department will calculate the payment reduction on the invoice cost of the material delivered at the project site. The Department will reject geotextile fabric that fails and has not been incorporated into the work.

AOS PAYMENT REDUCTION					
#35 - #40 or #45 - #50 Glass Beads Passing Fabric as Applicable	0-5	6-10	11-15	16-20	21 or more
Reduction Rate	0%	20%	30%	40%	*

GRAB STRENGTH PAYMENT REDUCTION				
% of Requirement	100% or more	90-99%	75-89%	74% or Less
Reduction Rate	0%	25%	40%	*

ELONGATION PAYMENT REDUCTION (TYPE I FABRIC ONLY)				
% of Requirement	100% or more	90-99%	75-89%	74% or Less
Reduction Rate	0%	25%	40%	*

SEWN SEAM STRENGTH PAYMENT REDUCTION				
% of Requirement	100% or more	90-99%	75-89%	74% or Less
Reduction Rate	0%	25%	40%	*

FLOW RATE PAYMENT REDUCTION				
% of Requirement	100% or more	90-99%	75-89%	74% or Less
Reduction Rate	0%	25%	40%	*

**Remove and replace the fabric unless the Engineer determines the fabric can remain in place at a 100% reduction rate.*

843.01.03 Fastener Pins. The Engineer will accept fastener pins based on visual inspection on the project. Conform to the following:

A) Underdrain Systems. Use pins that are formed of No. 9 diameter or heavier steel wire and are at least one foot long with a 4-inch right angle bend on one end.

B) Slope Protection, Channel Lining, Subgrade and Embankment Foundation Stabilization, and Wrapped Aggregate Drainage Blankets. Provide fastener pins that are formed of 3/16 inch diameter or heavier steel, pointed at one end, with a head on the opposite end to retain a washer with a minimum diameter of 1 1/2 inches.

SECTION 844 — MINERAL ADMIXTURES FOR CONCRETE

844.01 FLY ASH REQUIREMENTS. For fly ash added to concrete mixtures as a separate ingredient, conform to ASTM C 618, Class F or Class C, except ensure that the loss on ignition does not exceed 3.0 percent.

Concrete containing Class C fly ash may reduce sulfate resistance. Susceptibility to sulfate attack relates to the resistance factor, R. The value of R is defined as the ratio, $(CaO - 5.0)/(Fe_2O_3)$, as determined from the fly ash oxide analysis. A resistance factor (R) greater than 3.0 indicates a reduction in sulfate resistance. Do not use Class C fly ash having an R ratio greater than 3.0 in concrete where sulfate attack is possible. Identify the locations on the project where concrete containing Class C fly ash is to be used, and obtain the Engineer's approval of its use before beginning concrete work.

844.02 APPROVAL.

844.02.01 Fly Ash. Select from the Department's List of Approved Materials for fly ash sources. To be placed on the list, furnish samples and ASTM C 618 test data developed over the previous 3 months, and conform to the following requirements:

1) Ensure that the fly ash supplier has a quality control program satisfactory to the Engineer, to ensure the fly ash delivered to the project has uniform properties conforming to this section. To be acceptable, laboratories performing tests on fly ash for conformance to ASTM C 618 shall participate in the laboratory evaluation and sample proficiency program conducted by the Cement and Concrete Reference Laboratory of ASTM. This requirement does not apply to routine process control testing at the plant site for fineness, loss on ignition, and uniformity. A Department certified technician shall perform testing at the plant.
2) Provide with each shipment of fly ash a certification from the supplier that the fly ash complies with this section and ASTM C 618.
3) Provide with each shipment actual results of tests for fineness and loss on ignition, and uniformity when applicable. The concrete producer shall keep these test results on file and available for review by the Engineer for a period of at least 3 years after receipt of the fly ash.
4) The Department reserves the right to perform any sampling and testing on Type IP cement or fly ash when deemed necessary or desirable.

844.02.02 Ground Granulated Blast Furnace (GGBF) Slag. The Department's Division of Materials maintains a list of approved GGBF Slag sources by producer. Furnish samples and ASTM C 989 test data for the previous six months and meet the following requirements to obtain approval.

1) Submit the GGBF slag supplier's quality control program to the Engineer for approval. The GGBF slag delivered to the project shall have uniform properties complying with this specification. Laboratories performing tests on GGBF slag for conformance to ASTM C 989 shall participate in the laboratory evaluation program conducted by the Cement and Concrete Reference Laboratory of ASTM.
2) Submit certification with each shipment of GGBF slag to document its compliance with this specification and ASTM C 989.
3) Submit actual ASTM C 989 test results for fineness, air content, slag activity index, sulfide sulfur content, and sulfate ion content with each shipment.

The Department reserves the right to perform all sampling and testing on GGBF slag that it deems necessary or desirable.

844.02.03 Microsilica. The Department's Division of Materials maintains a list of approved microsilica admixtures by brand name and manufacturer. Furnish samples and

AASHTO M 307 test data for the previous six months and meet the following requirements to obtain approval:

1) Submit the microsilica supplier's quality control program to the Engineer for approval. The microsilica delivered to the project shall have uniform properties complying with this specification. Laboratories performing tests on microsilica for conformance to AASHTO M 307 shall participate in the laboratory evaluation program conducted by the Cement and Concrete Reference Laboratory of ASTM.
2) Submit certification with each shipment of microsilica to document its compliance with this specification and AASHTO 307.
3) Submit actual AASHTO M 307 tests results for the chemical and physical requirements with each shipment.

844.03 NON-SPECIFICATION FLY ASH. When either Class C or Class F sampled fly ash fails to meet specification requirements for loss on ignition (LOI), but the Engineer determines that concrete produced using the fly ash meets requirements for entrained air and compressive strength, the Engineer will reduce the price by 5.0 percent of the Contractor's invoice cost of the fly ash for each 0.1 percent that the fly ash LOI is above 3.0 percent. This procedure is intended to provide for acceptance at a reduced Contract price when material is discovered to not meet specification requirements after work is performed, and is not intended as a means to utilize non-specification material.

The Engineer will accept fly ash on the basis of certification and being from an approved source and project samples passing the applicable requirements of ASTM C 618 and/or ASTM C 593. Some variability or small departures from the requirements do not adversely affect properties of the finished product enough for removal and replacement. Therefore, the Department will use the following pay tables when deviations occur. When a sample fails more than one test, the Department will impose the largest reduction rate. The Department will calculate the payment reduction on the invoice cost of the fly ash delivered to the concrete plant or to the project site.

FINENESS PAYMENT REDUCTION				
% Retained on No. 325 Sieve	0-34	35-40	41-45	46 or more
Reduction Rate	0%	25%	50%	*

STRENGTH ACTIVITY INDEX PAYMENT REDUCTION				
Control with Cement (%)	75 or more	70-74	65-69	64 or less
PSI with Lime (Class F)	800 or more	775-799	750-774	749 or less
Reduction Rate	0%	25%	50%	*

AUTOCLAVE EXPANSION PAYMENT REDUCTION				
Expansion ± (%)	0.8	0.9	1.0	1.1 or more
Reduction Rate	0%	25%	50%	*

WATER REQUIREMENT PAYMENT REDUCTION				
Control (%)	105 or less	106-110	111-115	116 or more
Reduction Rate	0%	25%	50%	*

CHEMICAL REQUIREMENTS PAYMENT REDUCTION				
$SiO_2+Al_2O_3+Fe_2O_3$ (%) (Class F)	70 or more	65-79	60-64	59 or less
$SiO_2+Al_2O_3+Fe_2O_3$ (%) (Class C)	50 or more	45-49	40-44	39 or less
SO_3 (%)	0-5	6	7	8 or more
Moisture Content (%)	0-3	4	5	6 or more
Available Alkalies as (Na_2O) (%)	0-1.5	1.6	1.7	1.8 or more
Reduction Rate	0%	25%	50%	*

**Remove and replace finished product unless the Engineer determines that it can remain in place at a 100% reduction rate.*

SECTION 845 — FABRIC WRAPPED BACKFILL DRAIN MATERIALS

845.01 DESCRIPTION. Place fabric wrapped backfill drains at locations where depth to weep hole flowline is 30 feet or less.

845.02 FABRIC WRAPPED BACKFILL DRAIN. Select from the Departments List of Approved Materials. Provide Class I fabric wrapped backfill drains when the depth to weep hole flowline is 12 feet or less. Provide Class II fabric wrapped backfill drains when the depth to weep hole flow line is between 12 feet and 30 feet.

845.02.01 Compressive Strength. Ensure the drain is capable of withstanding the following compressive load on the wide side, with a maximum deflection of 50 percent:

Class I - 2,000 pounds per square foot.
Class II - 5,000 pounds per square foot.

845.02.02 Core. Use a rectangular core at least 17 inches wide, with nominal thickness of at least 0.7 inch, consisting of molded plastic; or of a 3-dimensional structure of mono-filaments bonded at their intersections; or of 3/8-inch average diameter expanded polystyrene beads bound together with an adhesive compound, sufficiently open to allow free movement of water entering through the geotextile fabric, and manufactured specifically for drainage applications.

845.02.03 Wrapping. Wrap the core on all 4 sides with Type II geotextile fabric conforming to the requirements of Section 845.

845.03 PACKAGING AND CARE. Wrap the drain in a protective covering to protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140 °F, mud, dirt, dust, and debris during all periods of shipment and storage.

Completely cover with backfill material within 14 calendar days after placement. If completely backfilling the drain is not feasible, cover exposed portions with approved material to protect the fabric from direct sunlight. Remove and replace any drain not backfilled or suitably covered within 14 days after placing at no expense to the Department.

845.04 ACCEPTANCE. Furnish the manufacturer's certification to the Engineer stating the fabric wrapped backfill drains meets all requirements herein. The Engineer will accept the fabric wrapped backfill drains by certification and visual inspection.